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Draft Environmental Impact Statement, Wastewater Treatment Facilities/City of Fort Worth, Tarrant County, Texas

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The City of Fort Worth proposes to construct wastewater treatment facilities (WWTF) to collect and adequately treat 137 million gallons per day of wastewater through the design year 2005. The City proposes to expand the existing Village Creek WWTF and dispose of sludge by landfilling in the Trinity River floodplain. A number of alternatives were evaluated including sludge disposal by surface landspreading, wastewater treatment by slow rate irrigation - an alternative technology - and no action. EPA, through the Texas Department of Water Resources, is considering approval and funding of improvements to and expansion of the system, as well as providing no funding. Many complex issues bear on EPA's decision, including impacts relating to water quality, odors, and socioeconomic conditions.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
INTERFIRST TWO BUILDING, 1201 ELM STREET
DALLAS, TEXAS 75270

July 1, 1983

TO ALL INTERESTED AGENCIES, OFFICIALS, PUBLIC GROUPS AND INDIVIDUALS:

Attached is a copy of the Draft Environmental Impact Statement (EIS) on the awarding of a construction grant under Section 201 of the Clean Water Act for the upgrading and expansion of wastewater treatment facilities for Fort Worth, Texas and its service area. The EIS has been prepared concurrently with a wastewater treatment facilities plan under a grant from the U.S. Environmental Protection Agency (EPA). This document has been prepared in compliance with the National Environmental Policy Act of 1969 and implementing regulations.

EPA and the City of Fort Worth will hold a public hearing on the Draft EIS and the draft facilities plan at 7:30 p.m., Thursday, August 18, 1983 in the City Council Chambers of the Fort Worth Municipal Building, 1000 Throckmorton, Fort Worth, Texas. Comments made at the public hearing and written comments received by EPA will be considered in the preparation of the Final EIS.

If changes required on the Draft EIS are minor, the Final EIS will incorporate the Draft EIS by reference and include only: 1) a revised and updated summary; 2) revisions necessary to the Draft EIS; 3) EPA's response to comments on the Draft EIS; 4) conclusions. Therefore, the Draft EIS should be retained for possible use in conjunction with the Final EIS. The Final EIS will be sent only to those who request a copy or who make substantive comments on the Draft EIS.

The Draft EIS is being distributed to Federal, State and local agencies and other interested parties. The Draft EIS, supporting information and the draft facilities plan may be reviewed at the following locations:

Fort Worth Water Department
1000 Throckmorton
Fort Worth, Texas

Fort Worth Public Library
300 Taylor Street
Fort Worth, Texas

Arlington Public Library
101 East Abram
Arlington, Texas

North Central Texas Council
of Governments
1201 North Watson Road at Hwy 360
Arlington, Texas

U.S. Environmental Protection Agency
28th Floor, InterFirst Two Building
1201 Elm Street
Dallas, Texas

Written comments on this EIS should be addressed to Mr. Clinton B. Spotts, Regional EIS Coordinator, at the above address by the date stamped on the cover sheet following this letter. If you need additional information please contact Mr. Spotts at 214-767-2716 or FTS 729-2716.

Sincerely yours,

Myron O. Knudson
for
Dick Whittington, P.E.
Regional Administrator

DRAFT ENVIRONMENTAL IMPACT STATEMENT

WASTEWATER TREATMENT FACILITIES
CITY OF FORT WORTH, TEXAS

Responsible Agency: U.S. Environmental Protection Agency, Region 6

Action Being Considered: Possible awarding of construction funds for wastewater treatment facilities in Fort Worth, Tarrant County, Texas

Contact for Further Information:

Clinton B. Spotts, Regional EIS Coordinator
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Abstract:

The City of Fort Worth proposes to construct wastewater treatment facilities (WWTF) to collect and adequately treat 137 million gallons per day of wastewater through the design year 2005. The City proposes to expand the existing Village Creek WWTF and dispose of sludge by landfilling in the Trinity River floodplain. A number of alternatives were evaluated including sludge disposal by surface landspreading, wastewater treatment by slow rate irrigation - an alternative technology - and no action. EPA, through the Texas Department of Water Resources, is considering approval and funding of improvements to and expansion of the system, as well as providing no funding. Many complex issues bear on EPA's decision, including impacts relating to water quality, odors, and socioeconomic conditions.

Date Comments Due: AUG 29 1983

Responsible Official: Myron O. Knudson

for Dick Whittington, P.E.
Regional Administrator

1.0 SUMMARY

1.1 DESCRIPTION OF ADMINISTRATIVE ACTION

The National Environmental Policy Act (NEPA) stipulates that each Federal agency shall ". . . include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on the environmental impact of the proposed action; any adverse environmental effects which cannot be avoided should the proposal be implemented; and alternatives to the proposed action...." This legislation is the basic framework for the Environmental Impact Statement (EIS).

One of the major programs conducted by the US Environmental Protection Agency (EPA) which involves actions that may require an EIS is the Construction Grants Program, as authorized by Title II -- "Grants for Construction of Treatment Works," Section 201 (g) (1), of the Federal Water Pollution Control Act Amendments of 1972 (FWPCA), Public Law 92-500. This law authorizes the EPA Administrator ". . . to make grants to any State, municipality, or intermunicipal or interstate agency for construction of publicly-owned treatment works . . ." Major provisional changes were made to the FWPCA by the Clean Water Act of 1977 (CWA), Public Law 95-217, and by the Municipal Wastewater Treatment Construction Grant Amendments of 1981, Public Law 97-117. Many of the changes are directed toward emerging public philosophies and address concerns about priority water quality areas; chemical pollution; resource conservation, recovery, and recycling; financial capabilities of the grant applicant; treatment system performance; and environmentally compatible treatment systems. Key provisions of the CWA (as amended) that directly affect the construction grants program include:

- Prior to 1 October 1984, EPA may fund up to 75 percent of the grant eligible costs of constructing facilities designed to use conventional wastewater treatment technologies, and up to 85 percent of facilities designed to use innovative/alternative technologies. On or after 1 October 1984, EPA may fund up to 55 percent of the costs of conventional facilities, and up to 75 percent of the costs of innovative/alternative facilities;

- Municipalities are required to consider alternative or innovative systems that provide for reclaiming, reuse, or recycling of wastewater; elimination of discharges; and recovery of energy. As an incentive for increased utilization of these systems, EPA not only may provide up to 20 percent additional grant funds for alternative or innovative systems, but may pay 100 percent of the cost of rebuilding or modifying an innovative system that fails to meet its permit conditions;

- EPA may provide a 15 percent "cost effective bonus" for alternative or innovative systems when compared in a cost-effectiveness analysis with conventional technologies;

- Applicants for grant funds must analyze methods, processes, and techniques to reduce total energy consumption and to increase the open space and public recreation potential of lands, waters, and rights-of-way that are parts of a proposed project;

- The objectives of the CWA for sewage sludge management are to insure protection of public health and the environment by promulgation of minimum Federal standards for sludge disposal and utilization and to maximize beneficial uses of sludges that conform to Federal standards; and

- EPA may delegate the management and administration of the Construction Grants program to the states, to manage the project to ensure its timely and economical completion and to eliminate duplicate review of the project documents.

On 24 August 1977, EPA awarded a grant (C-48-1323) to the City of Fort Worth (City) to assist the City in conducting facilities planning for a wastewater collection and treatment system to properly handle flows which would exceed the capacity of the existing 96 million gallons per day (mgd) Village Creek wastewater treatment facilities (WWTF). The facilities planning area includes most of Tarrant and a portion of Johnson counties. Since there was a potential that new and/or expanded wastewater treatment facilities, sludge treatment and/or disposal facilities, or the environmental effects of proposed facilities might extend outside of the facilities planning area, a study area was established which also included other parts of Johnson County and parts of Denton, Wise and Ellis counties. EPA determined that awarding of grant funds for construction of wastewater facilities would be a major Federal action with possible significant effects on the quality of the human environment, and on 28 June 1979 issued a Notice of Intent to prepare an EIS. It also was determined that the EIS would be prepared concurrently with preparation of the facilities plan (often called a "piggyback" EIS).

1.2 NEED FOR ACTION

The City determined that modifications to its present wastewater collection and treatment facilities were needed based on the following situations:

(1) Flows generated within the existing service area periodically exceed the capacity of the existing wastewater collection system.

(2) Capacity of the existing 96 mgd Village Creek WWTF potentially would be reached by year 1985. Also, peak flows of 3.4 times average enter the WWTF, causing operation and maintenance problems.

(3) The public in the vicinity of the Village Creek WWTF has expressed strong disapproval of odors generated by the treatment facilities.

(4) Federal regulations prohibit the City's practice of disposing sludge on public lands without disinfecting the sludge or controlling public access to the disposal sites.

(5) Dramatic increases in energy costs warrant greater emphasis on utilization of efficient energy recovery systems in association with wastewater collection and treatment.

(6) During approximately the last 4 years (from March 1979 through December 1982), the existing Village Creek WWTF produced a monthly average effluent quality which met the State of Texas minimum standard for secondary treatment five times, and which met current design limitations four times.

Recent improvements in the Village Creek WWTF effluent quality apparently resulted in a marked improvement in the quality of the West Fork Trinity River. Further improvements need to be made to enable the Village Creek WWTF to consistently meet wastewater treatment requirements and thus achieve further improvements to the quality of the West Fork Trinity River.

1.3 ALTERNATIVES TO THE CITY'S PROPOSED PROJECT

Many alternatives for wastewater collection, treatment, and disposal were evaluated during facilities planning. Initially, over 300 alternatives for wastewater management were identified and evaluated. Following evaluation of the 300 preliminary alternatives, 15 intermediate alternatives were identified for further development and evaluation. The 15 alternatives included both conventional treatment technologies, and alternatives involving innovative and/or alternative land treatment using slow rate irrigation, overland flow, or rapid infiltration. Evaluation of the 15 intermediate alternatives concluded with identification of four (4) final alternatives for detailed development and analysis.

The four final alternatives for wastewater collection and treatment identified by the City for detailed evaluation are as follows:

(1) Alternative 1. Alternative 1 would involve expanding the Village Creek WWTF to a capacity of 137 mgd. All required liquid treatment units would basically be the same as those at the existing WWTF, and would be built within the dikes surrounding the existing WWTF. Sludge would be mechanically dewatered at the Village Creek WWTF, and then transported by truck to a 175-acre stockpile area located in a 60,000-acre sludge disposal target area north of Saginaw, Texas. Sludge would be disposed in the target area by landspreading on approximately 22,000 acres of agricultural land at the rate of 2.6 tons per acre or less, or on grasslands at the rate of 5.0 tons per acre or less. Sludge would not be placed on food-chain crops. Improvements to the collection system and construction of the TRA transfer line would be as described in Section 1.4.

(2) Alternative 2A. Alternative 2A would involve expanding the Village Creek WWTF to a 137 mgd capacity, with all treatment units located inside the existing dikes. Sludge would be mechanically dewatered at the Village Creek WWTF, and then hauled by truck to a 175-acre stockpile area located in a 60,000-acre sludge disposal target area north of Saginaw, Texas. Sludge would be disposed in a municipal refuse landfill (co-disposal) located in the target area. Improvements to the collection system and construction of the TRA transfer line would be as described in Section 1.4.

(3) Alternative 2B. Alternative 2B would involve expanding the Village Creek WWTF to a 137 mgd capacity, and disposing of sludge in a sludge only landfill located in the West Fork Trinity River floodplain across (north) from the WWTF. Alternative 2B is the City's proposed project as described in Section 1.4.

(4) Alternative 3. Alternative 3 would involve maintaining the Village Creek WWTF at 96 mgd, with sludge mechanically dewatered and disposed by land spreading on approximately 15,000 acres located somewhere in a 60,000-acre sludge disposal target zone north of Saginaw, Texas. The remaining 41 mgd would be transported through dual pipelines to an 8,460-acre slow rate irrigation site located in Johnson County just northeast of Godley, Texas. The 41 mgd of wastewater would be treated in aerated lagoons and stored in a 90-day capacity storage reservoir. Wastewater from the reservoir would be applied by slow rate irrigation to 8,460 acres of farmland and grazingland at the rate of 1.25 inches per week. Sludge from the aerated lagoons also would be landspread in liquid form on the irrigated lands.

In addition to the four final alternatives, the alternative of taking no action was evaluated. The no action alternative would consist of the City doing nothing in the way of system expansion. In design year 2005, 137 mgd of wastewater in the present collection system would overflow existing sewer mains. High flows would exceed the capacity of the Village Creek WWTF, causing poorly treated effluent to be discharged to the West Fork Trinity River. Sludge would not be properly digested, and thus poorly-digested sludge would be placed on the sludge drying beds and then hauled to municipal refuse landfills for disposal.

1.4 DESCRIPTION OF THE CITY'S PROPOSED PROJECT

The City proposes to make improvements to their wastewater collection and treatment facilities to properly handle wastewater for a 20-year planning period, from 1985 to design year 2005. Major improvements are proposed for the following wastewater collection mains: Village Creek; Clear Fork; West Fork; Walker Branch; a 72-inch (in) diameter main designated M-245; and a 96-in diameter main designated M-280. The new and/or improved mains would convey a daily average design flow of 137 mgd to the Village Creek WWTF.

The Village Creek WWTF would be expanded at its present site to provide advanced secondary treatment for 137 mgd of wastewater. The expanded Village Creek WWTF would include the following new or modified treatment units:

- New primary screening and primary sedimentation tanks;
- New activated sludge secondary treatment facilities;
- New dual-media filtration advanced treatment facilities;
- New effluent disinfection (chlorination) units;
- New sludge thickening and anaerobic digestion units;
- New methane gas (energy) recovery and utilization facilities; and
- Odor control by chemical addition or other effective methods.

All of these wastewater treatment units would be constructed inside of the levees (i.e., dikes) surrounding the existing Village Creek WWTF. Treated effluent would be discharged to the West Fork Trinity River.

For the proposed project, use of existing sludge drying beds adjacent to the Village Creek WWTF would be discontinued; however, piping and other facilities associated with the drying beds would be retained so that the drying beds could be used under emergency conditions. Sludge produced at the Village Creek WWTF would be pumped through dual 12-in diameter pipelines to a 500-acre sludge disposal site across the West Fork Trinity River, due north of the existing WWTF. The 500-acre site is located entirely within the 100-year floodplain of the Trinity River. Sludge would be mechanically dewatered at the disposal site, and then disposed in a sludge only landfill occupying from 92 to 185 acres of land. The dewatering facilities and the landfill would be contained within a dike built in the floodplain to protect the facilities from flooding. In addition, the City would develop a program for beneficial reuse of sludge. Agricultural disposal of sludge, composting (disinfection) followed by bag marketing and/or disposal on public lands, reclaiming strip mines, and other experimental programs would be investigated as beneficial reuse concepts. The ultimate goal of the proposed project would be to beneficially use all sludge produced by the Village Creek WWTF.

To prevent the newly constructed levees (dikes) from causing flooding problems upstream or downstream, part of the existing dikes around the sludge drying beds would be moved back away from the Trinity River to provide additional area for floodwaters to pass through. Also, a flood relief channel(s) approximately 800 feet wide would be constructed on the 500-acre sludge disposal site to convey floodwaters past the newly diked landfill area.

Construction of the new facilities would not be completed by 1985, therefore, a wastewater transfer line would be built to convey wastewater from the Village Creek WWTF to the Trinity River Authority's (TRA) Central WWTF, which is located approximately 10 miles east of the Village Creek WWTF on the Trinity River. Up to 15 mgd of wastewater would be diverted from the Village Creek WWTF to the TRA Central WWTF for a 6-year period (1984-1990) or more depending on the need.

The proposed project would be built in three major phases:

- Phase I would involve adding liquid treatment, sludge, and odor control facilities to properly handle peak flows. Phase I would be fully operational in July 1986;
- Phase II would involve adding liquid treatment facilities to properly handle 120 mgd. Phase II would be completely operational in October 1989; and
- Phase III would involve adding liquid treatment and sludge treatment facilities to properly handle 137 mgd. Phase III would be fully operational in July 1994.

Construction of the proposed project would cost approximately $183 million, including engineering and administrative fees and other contingencies. An EPA grant could amount up to approximately $138 million dollars, provided the City is awarded a grant for 75% of the estimated project cost. For 55%, the EPA grant could amount up to approximately $101 million dollars. Operation and maintenance costs potentially would range from $8.3 million annually in 1985 to $9.1 million annually in 2005. The above estimates are based on September 1980 dollars. The total annual expense of the project to the City would average approximately $27.3 million for each year of the 20-year planning period. Total average monthly user charge (i.e., sewer bill) potentially would range from $10.46 to $15.32, depending on the amount of Federal grant funding (if any) actually made available to the City (total average monthly user charge includes $5.60 sewer bill for current services provided).

At this time no eligibility determinations have been made for any of the proposed facilities. EPA participated in the expansion of the Village Creek WWTF to 96 mgd annual average daily flow under grant No. C-481017. Any additional work required at the plant to achieve a treatment capacity of 96 mgd annual average daily flow would not be allowable for EPA participation. In addition, any existing treatment unit abandoned or replaced before its useful life has expired would be subject to EPA's policy on abandonment of construction grant assisted publicly owned treatment works.

1.5 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

Implementation of the no action alternative potentially would result in the following: overflow of raw sewage from collection mains would cause environmental health problems and water quality degradation throughout Fort Worth; significant undesirable odors in the vicinity of the Village Creek WWTF, sludge drying beds, and municipal refuse landfills used for ultimate disposal of inadequately digested and partially dried sludge; substantial degradation of water quality and associated loss of aquatic life in the West Fork Trinity River; stagnation of growth in Fort Worth and the customer communities due to the lack of adequate wastewater collection and treatment facilities; potential reduction of land values in the vicinity of the Village Creek WWTF; and aesthetically displeasing conditions along existing collection mains and in the vicinity of the Village Creek WWTF.

Construction and operation of any of the final four alternatives would result in both adverse and beneficial effects. Alternatives with similar components (e.g., Alternatives 1, 2A, and 2B all involve expansion of the Village Creek WWTF) would have similar effects. Adverse and/or beneficial effects which would occur as a result of implementing any of the four final alternatives are described in the following paragraphs.

Major effects to topography and sub-surface geology would not occur due to implementation of any final alternatives. Construction of dikes for Alternative 2B would involve minor topographic changes. Water holding capacity and erodibility of the soil would be beneficially affected by landspreading operations involved with Alternatives 1 and 3. There also would be an accumulation of toxic metals in soils used in landspreading operations of Alternatives

1 and 3; however, maximum concentrations of metals regulated by EPA would not be exceeded. Increased erosion potential would exist for all alternatives due to land-disturbing activities at the Village Creek WWTF, as well as construction of collection mains, the TRA transfer line, and various landfills and storage reservoirs.

Groundwater contamination would not occur due to landspreading activities with Alternative 1 because impermeable soils predominate at the landspreading site. Alternatives 2A and 2B also would not adversely affect groundwater because landfills would be constructed with clay and/or membrane liners in accordance with state requirements. Although permeable soils do exist in the Mustang Creek area, potable groundwater obtained from Trinity Group aquifers are approximately 300 to 400 feet deep. Contaminants in wastewater applied by slow rate irrigation would not travel to these depths, thus, Alternative 3 would not cause groundwater contamination problems.

Surface waters would undergo minimal quality degradation due to sedimentation and erosion from construction activities associated with all final alternatives. Minor increases in contaminated urban runoff also would occur with all final alternatives as an indirect impact caused by population growth and conversion of lands to urban uses allowed by available wastewater management capacities. Base flow in the West Fork Trinity River would increase as a result of increased effluent discharges from Alternatives 1, 2A, and 2B. The base flow of Mustang Creek and associated available raw water supply in Lake Benbrook also would increase during summer months due to runoff from the slow rate irrigation system utilized with Alternative 3. Water quality of the West Fork Trinity River would improve as a result of all alternatives due to a reduction in pollutants discharged from the improved Village Creek WWTF. Discharge of minor amounts of pathogenic organisims and toxic metals from sludge potentially would occur due to landspreading activities associated with Alternatives 1 and 3, and due to pilot beneficial reuse programs (e.g., sludge injection and/or agricultural landspreading) conducted outside of diked areas in the West Fork Triniy River floodplain as considered in Alternative 2B.

Substantial undesirable odors emanate periodically from the existing Village Creek WWTF. With all alternatives, odor control by chemical addition or other effective methods would be utilized. This would result in a reduction in the magnitude and frequency of adverse odors. Minor additional quantities of pathogenic aerosols would be produced by additional activated sludge tanks proposed in Alternatives 1, 2A, and 2B. Fugitive dust and noise would be generated during construction activities associated with all final alternatives, but fugitive dust would be substantial only from landspreading activities associated with Alternative 1. Moderate generation of odors and pathogenic aerosols would occur from aerated lagoons and slow rate irrigation facilities associated with Alternative 3; however, with the sparse population in rural areas near Godley, Texas a minimum number of sensitive receptors would be affected.

Loss of vegetation and associated wildlife habitat due to construction activities associated with all final alternatives would be minor. Pesticides (insect killers) and herbicides (weed killers) used in conjunction with landspreading activities of Alternatives 1 and 3 would potentially affect wildlife. Aquatic biota in the West Fork Trinity River would diversify due to improved effluent quality and subsequent improved water quality due to all final alternatives. Conversion of irrigated lands to growth of harvested grain and/or hayfields as part of Alternative 3 would cause a potentially substantial loss of acreage in unharvested grain used for food by gamebirds. Destruction of 4.4 acres of USCOE - designated wetlands would occur with Alternative 2B due to the construction of the sludge only landfill, flood levees, and flood relief channels.

A pedestrian survey conducted by a TDWR staff archaeologist of the sludge-only landfill, flood levees, flood relief channels, and collector lines for Alternative 2B located three archaeological sites. Two of the sites are considered to be significant and potentially eligible for nomination to the National Register of Historic Places. However, adverse impacts to these sites may be avoided by relocation of collector line routes. Adverse effects on cultural resources due to implementation of any of the final alternatives would be minimized by EPA compliance with Section 106 of the National Historical Preservation Act, as amended. Finding and recording of significant cultural resources constitutes a beneficial effect.

Providing proper wastewater collection and treatment facilities through implementation of any of the four final alternatives would result in continued moderate population growth in the facilities planning area, in accordance with current expectations of regional planning agencies. Substantial population movement or relocation would not occur due to development of any of the four final alternatives.

Predominant land uses in the project region are agricultural, primarily cropland and rangeland. Urban uses are increasing in Tarrant County consistent with population growth of the area. Implementation of any of the four final alternatives would not substantially change land use or land use trends in the facilities planning area.

Transportation in the project area is primarily via automotive vehicles. Major beneficial and/or adverse effects would not occur to transportation systems due to construction and operation of any of the four final alternatives. Minor traffic congestion would occur due to construction traffic generated during construction of any of the four final alternatives. Hauling dewatered sludge to landspreading or landfill sites as part of Alternatives 1, 2A or 3 also may cause minor traffic disruptions on local streets. Disruption to community services such as water, natural gas, and electric utility service also would occur in isolated cases due to accidental utility line breakage during construction of collection lines and/or force mains associated with each of the four final alternatives.

Economic conditions in the project region are stable with a well diversified economic base. Major adverse effects to the regional economy would not occur due to implementation of any of the four final alternatives. Any of the four final alternatives would be financed potentially with Federal grant funds and through sale of municipal bonds. Construction would be phased to avoid unreasonable municipal financial burdens. Facilities total average user charges (i.e., monthly sewer bills) for the City's proposed project (Alternative 2B) potentially would range from $10.46 per month to $15.32 per month during the 20-year planning period. Costs for other alternatives would be slightly higher.

Supplies of electrical energy, natural gas, propane, and motor fuels (e.g., gasoline and diesel) in the project region are adequate and would not be adversely affected by energy demands associated with any of the four final alternatives. All four final alternatives provide for methane produced by anaerobic digestors to be utilized for fuel and electrical energy production at the Village Creek WWTF. Approximately 45 percent of the total energy requirement of the Village Creek WWTF would be provided by energy (methane) recovery and utilization facilities at the WWTF.

Serious environmental health effects are not anticipated to occur as a result of implementation of any of the four final alternatives. Minor problems with nuisance vectors (e.g., flys and mosquitoes) potentially would occur due to all alternatives. Serious environmental health problems resulting from generation of pathogenic aerosols by wastewater treatment facilities have not been substantiated. Environmental health problems associated with sludge disposal would not occur if state and Federal regulations concerning landspreading and/or landfilling practices are followed.

Recreational and aesthetic resources would not be adversely affected by implementation of any of the four final alternatives. Adequate site selections and establishment of buffer zones and pleasant landscaping would avoid adverse aesthetic (e.g., visual) effects of sludge disposal systems. Recreational opportunities along the West Fork Trinity River may increase due to improved water quality. Although the City recognized recreational opportunities associated with pipeline rights-of-way (e.g., hike and bike trails), such recreational facilities currently are not proposed as part of the four final alternatives.

Alternatives available to EPA through the TDWR basically include: (1) awarding of a grant for eligible cost of construction of wastewater treatment facilities, and (2) denial of a grant. A grant agreement also can be modified by EPA placing conditions on the grant. The USCOE would have the alternative of issuing or denying a Section 404 permit for the discharge of dredged and fill material into waters of the United States, including adjacent wetlands, and a Section 10 permit for any work in a navigable water. Denial of a grant and/or permit by EPA or other agencies might result in the City taking no action, and thus the effects potentially would be similar to effects of the no action alternative previously described. However, the City is responsible for meeting its wastewater discharge permits regardless of whether Federal assistance is received. Awarding of a construction grant and issuance of appropriate permits would most likely result in construction of wastewater treatment system improvements and expansion with associated effects present for various disciplines as described in Section 1.5 of this Chapter.

1.6 COORDINATION

EPA Region 6, TDWR, and the City of Fort Worth have made a concerted effort to involve other Federal, state, and local agencies and the general public in the development of this document. A public scoping meeting was held on 15 August 1979 in Fort Worth. Two public meetings were held to discuss the screening of alternatives and progress of the facilities plan and the EIS. Thirteen Citizens Advisory Committee meetings were held. Additionally, public information depositories were established and are being maintained in three convenient public buildings located in Tarrant County for the duration of the project. A public hearing to receive comments on the Draft EIS and draft facilities plan will be held in Fort Worth after publication of the Draft EIS.

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3.0 INTRODUCTION, PURPOSE, AND NEED

3.1 EPA LEGISLATIVE AUTHORITY AND RESPONSIBILITIES

Decisions made by the City of Fort Worth concerning water and wastewater management are subject to laws, regulations, and grant programs of the Federal government, especially Congressional mandates known as the Clean Water Act and the National Environmental Policy Act.

3.1.1 Clean Water Act

In 1972, Congress enacted Public Law 92-500 (P.L. 92-500), Amendments to the Federal Water Pollution Control Act, in order to establish a comprehensive program to "restore and maintain the chemical, physical and biological integrity of the Nation's waters". Because municipal sewage is one of the major point sources of water pollution in the US, Title II of the new law provided for an expanded program of Federal assistance for construction of sewage treatment facilities, and gave EPA authority to fund 75 percent of the cost of planning, designing and constructing such facilities, provided that local governments supply 25 percent of the necessary financial support. EPA grants normally were given in three steps: Step 1--initial planning; Step 2--detailed design; and Step 3--actual construction. Under the law, the initial planning phase emphasizes a long-range look at a wide variety of alternatives for collection, treatment, and ultimate disposal of waterborne wastes. Actions which promote reclamation and reuse of wastewater are especially encouraged by the Act, as are clean-up of wastes to the point that no discharge of pollutants occurs from a treatment facility.

Public Law 92-500 also requires that a permit be issued for any wastewater discharge to the waters of the US. The permit is referred to as the National Pollutant Discharge Elimination System (NPDES) permit. Compliance with the water quality requirements of a wastewater plant's NPDES permit is a mandatory objective of the facilities planning process.

In 1977, Congress passed Public Law 95-217, which revised portions of P.L. 92-500. Collectively, the complete amended act is referred to as the Clean Water Act (CWA). Emphasis was placed upon giving planning consideration to innovative technologies for water reuse, energy conservation and/or complete removal of pollutants. Selection of innovative alternatives such as land treatment of sewage was encouraged by the availability of 85 percent Federal participation in facility design and construction, instead of the conventional level of 75 percent funding.

Subsequently, Congress passed the Municipal Wastewater Treatment Construction Grant Amendments of 1981 (Public 97-117). P.L. 97-117 made major provisional changes to the CWA. Many of the changes are directed toward emerging public philosophies, and address concerns about chemical pollution, resource conservation, resource recovery and recycling, environmentally compatible treatment systems, and streamlining Federal involvement in the planning and design of municipal wastewater treatment facilities. Key provisions of P.L. 97-117 that directly affect the construction grants program include:

- Municipalities will conduct wastewater collection and treatment facilities planning and design efforts without Federal funding prior to requesting construction grants from EPA;
- Municipalities are required to consider alternative or innovative systems that provide for reclaiming, reusing, or recycling wastewater; elimination of discharges; and recovery of energy. As an incentive for increased utilization of these systems, EPA still may provide 85 percent funding (through September 1984) for alternative or innovative systems, as opposed to 75 percent for conventional systems, and will pay 100 percent of the cost of rebuilding or modifying an alternative or innovative system that fails to meet its permit conditions or shows higher operation and maintenance (O&M) costs within two years of completion of construction. After 1 October 1984, EPA potentially will provide 75 percent funding for alternative or innovative systems, and 55 percent funding for conventional systems. All potential Federal funding is subject to availability of limited construction grant funds;
- In general, EPA will only fund construction of the most cost-effective waste treatment system, as determined by a cost-effectiveness analysis;
- EPA may provide a 15 percent "cost-effectiveness bonus" for alternative or innovative systems when compared in a cost-effectiveness analysis with conventional technologies. This means EPA may award assistance for a project or portion of a project determined to be innovative or alternative if the total present worth cost of the treatment works for which the grant is to be made does not exceed the total present worth cost of the most cost-effective alternative by more than 15 percent;

- Applicants for grant funds must analyze methods, processes, and techniques to reduce use of or reclaim energy and to increase the open space and public recreation potential of lands, waters, and rights-of-way that are part of a proposed project; and

- The objectives of P.L. 97-117 for sewage sludge management are to ensure protection of public health and the environment by promulgation of minimum Federal standards for sludge disposal and utilization and to maximize beneficial uses of sludges that conform to Federal standards.

3.1.2 National Environmental Policy Act (NEPA)

NEPA is Public Law 91-190, and was signed into law in 1969. There are six specific environmental objectives of Federally-funded actions, set forth in section 101(b) of NEPA:

(1) To fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.

(2) To assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.

(3) To attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable or unintended consequences.

(4) To preserve important historic, cultural, and natural aspects of our national heritage, and to maintain wherever possible an environment which supports diversity and variety of individual choice.

(5) To achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities.

(6) To enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

NEPA requires that an EIS be prepared by Federal agencies which propose a major action that significantly affects the quality of the human environment. The EIS must provide information to be used in Federal decision-making. Section 102(2)(c) of NEPA requires the EIS to consider:

- The environmental impact of the proposed action;

- Any adverse environmental effects which cannot be avoided should the proposal be implemented;

- Alternatives to the proposed action;

- The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity; and
- Any irreversible and irretrievable commitments of resources which would be involved due to implementation of the proposed action.

Based on the most recent regulations regarding EIS preparation (CEQ, 1978), the document is to concentrate on key issues as determined through an early public "scoping" process, and as further defined during the public participation process. The public participation program may include the formation of a Citizens Advisory Committee (CAC) of local citizens to review and provide advice in the facilities plan and EIS process. The EIS must provide a concise analytical statement which concentrates on evaluation of real alternatives.

3.2 INVOLVEMENT OF OTHER AGENCIES

During preparation of a wastewater facilities EIS, coordination among Federal, state, and local agencies involved with water quality management planning is essential for effective planning and decision making. EPA and the City of Fort Worth have communicated with and received input from many Federal, state, and local agencies during preparation of this Draft EIS, including but not limited to:

- US Advisory Council on Historic Preservation (ACHP)
- US Army Corps of Engineers (USCOE)
- US Department of Interior/Fish and Wildlife Service (USFWS)
- US Department of Agriculture/Soil Conservation Service (SCS)
- US Department of Health and Human Services (USDHHS)
- US Geological Survey (USGS)
- US Public Health Service (USPHS)
- US Water Resources Council (WRC)
- Texas Department of Water Resources (TDWR)
- Texas Department of Highways and Public Transportation (TDHPT)
- Texas Parks and Wildlife (TPW)
- Texas State Historic Preservation Officer (SHPO)
- North Central Texas Council of Governments (NCTCOG)
- Tarrant County
- Other Local City Governments

Wastewater management systems described and evaluated within this Draft EIS are subject to numerous state and Federal legislative and institutional requirements. Treatment and disposal of wastewater sludge has not been singled out for separate legislative treatment, but instead has been included within the statutory scope of regulations concerning substances generally considered to be pollutants that are disposed on land. Disposal of sludge on land has been legally and successfully practiced in the past, provided that the procedures used met requirements applicable in general to solid wastes, and did not conflict with general nuisance laws or restrictions on use of the land in question. Table 3-1 lists pertinent Federal, state, and local environmental legislation and regulations affecting wastewater management alternatives that are applicable to the City of Fort Worth wastewater management system.

3.3 BACKGROUND ON GRANT APPLICANT AND PREVIOUS GRANT APPLICATIONS

The City of Fort Worth (hereafter referred to as City) is located in Tarrant County in north central Texas (Figure 3-1). The City provides sewage collection and treatment services to Fort Worth and to 21 additional customer communities (Table 3-2) located within Tarrant County. Fort Worth and the surrounding customer communities currently are experiencing a moderate growth rate of approximately 2% per year, which is not uncommon to large metropolitan areas in the "sun-belt" region of the southern United States. Providing and maintaining sewage collection and treatment facilities for most of Tarrant County is a major responsibility undertaken by the City of Fort Worth.

Fort Worth has been conducting wastewater treatment facilities planning and construction efforts under current regulatory requirements almost continuously since the early 1970's. The City, in cooperation with the North Central Texas Council of Governments (NCTCOG), Texas Department of Water Resources (TDWR), and US Environmental Protection Agency (EPA) has participated in the continuing development of a Regional Sanitary Sewage Plan for the Upper Trinity River Basin. Plans previously developed called for a reduction, to a practicable minimum, of the number of wastewater treatment plants active in the Upper Trinity River Basin. In 1973, an engineering report and an environmental impact statement for the Fort Worth planning area were completed which called for:

- Abandonment of the Riverside wastewater treatment facility (WWTF) in east Fort Worth;

TABLE 3-1. KEY FEDERAL, STATE, AND LOCAL ENVIRONMENTAL AUTHORITY, LEGISLATION, AND REGULATIONS APPLICABLE TO THE CITY OF FORT WORTH WASTEWATER MANAGEMENT SYSTEM

FEDERAL AUTHORITY	APPLICABLE FEDERAL REGULATIONS
Clean Water Act, as amended	National Pollution Discharge Elimination System (NPDES), (40 CFR Part 125) Federal Construction Grants Regulations (40 CFR Part 35) Regulation Governing Waters of the United States (33 CFR Parts 323, 324)
River and Harbor Act of 1899	Regulation Governing Navigable Waters (33 CFR Part 322)
Safe Drinking Water Act, as amended	National Primary and Secondary Drinking Water Regulations (40 CFR Parts 141, 142, and 143)
Clean Air Act, as amended	
National Environmental Policy Act of 1969	Council on Environmental Quality Regulations (40 CFR Part 1500) EPA Final Regulations for the Preparation of EIS's (40 CFR Part 6)
Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976	Hazardous Waste Regulations (40 CFR Parts 260-266) Criteria for the Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257)
Toxic Substances Control Act	PCB Regulations (40 CFR Part 761)
Noise Control Act of 1972	
National Historic Preservation Act of 1966, as amended	Procedures of Advisory Council on Historic Preservation (36 CFR Part 800)
Executive Order 11593 - Protection and Enhancement of Cultural Environments	

TABLE 3-1. KEY FEDERAL, STATE, AND LOCAL ENVIRONMENTAL AUTHORITY, LEGISLATION, AND REGULATIONS APPLICABLE TO THE CITY OF FORT WORTH WASTEWATER MANAGEMENT SYSTEM (CONCLUDED)

FEDERAL AUTHORITY	APPLICABLE FEDERAL REGULATIONS
Archaeological and Historic Preservation Act of 1974	
Fish and Wildlife Coordination Act	Procedures of US Fish and Wildlife Service (50 CFR 402).
Endangered Species Act, as amended	
Executive Order 11990 - Protection of Wetlands	
Executive Order 11988 - Floodplain Management	
STATE LEGISLATION	**APPLICABLE STATE REGULATIONS**
Texas Water Code as amended	Regulations of the Texas Water Commission and the Texas Department of Water Resources
Texas Parks and Wildlife Code	Regulations of the Texas Parks and Wildlife Department
Texas Clean Air Act as amended	Regulations of the Texas Air Control Board
Texas Sanitation Code as amended	Regulations of the Texas Department of Health
Texas Solid Waste Act of 1974 as amended	
Texas Antiquities Code	Regulations of the Texas State Historic Preservation Officer
LOCAL REGULATIONS	
Local ordinances regarding: zoning, plumbing, traffic, and solid waste disposal	

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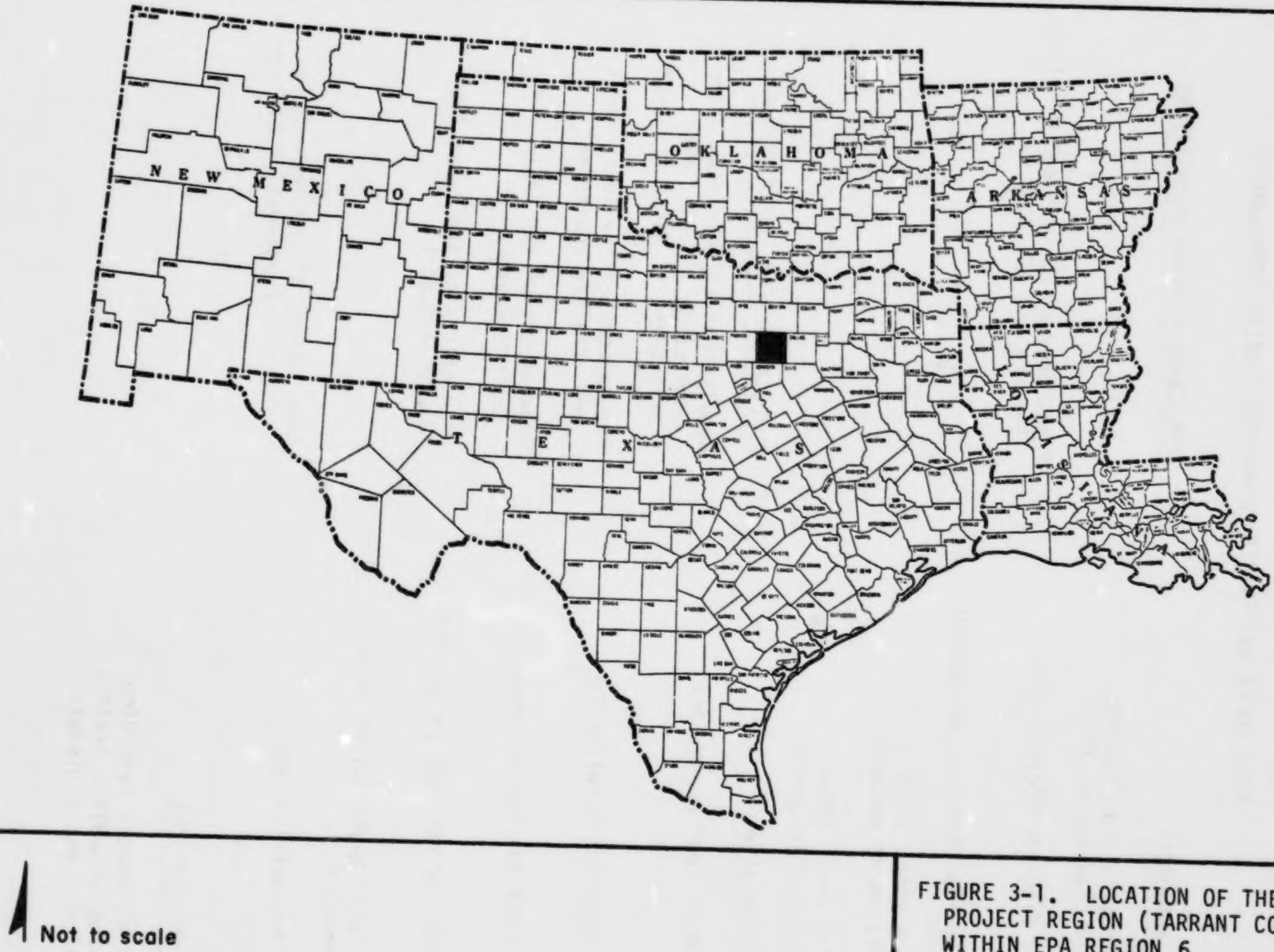

FIGURE 3-1. LOCATION OF THE PROJECT REGION (TARRANT COUNTY) WITHIN EPA REGION 6.

TABLE 3-2. COMMUNITIES CURRENTLY SERVED BY THE CITY OF FORT WORTH SEWERAGE SYSTEM

Arlington
Benbrook
Burleson
Crowley
Dalworthington Gardens
Edgecliff Village
Everman
Forest Hill
Fort Worth
Haltom City
Hurst
Kennedale
Lake Worth Village
North Richland Hills
Pantego
Richland Hills
River Oaks
Saginaw
Sansom Park
Tarrant County Municipal Utility District #1
Westover Hills
Westworth Village
White Settlement

SOURCE: CDM et al. 1983.

- Expansion of the Village Creek WWTF from a 45 million gallons per day (mgd) facility designed to produce an effluent of 27 milligrams per liter (mg/l) biochemical oxygen demand (BOD) and 30 mg/l total suspended solids (TSS), to a plant with a 96 mgd capacity capable of producing an effluent of 10 mg/l BOD and 10 mg/l TSS;
- Utilization of open drying beds constructed near the Village Creek WWTF, protected by levees, for achieving dewatering of sewage sludge; and
- Final disposal of sludge by use as a soil conditioner on city, state, and Federal lands.

The 1973 engineering report was developed for design year 1980, and was completed in order to achieve the following goals:

(1) Reduction of potential health hazards which might otherwise result from discharge of untreated or poorly treated wastewater into the Trinity River or its tributaries.

(2) Improvement of the general aesthetics of the project area to make it a good neighbor to other development which may materialize in contiguous areas.

(3) Reduction of air pollution from wastewater treatment plant odors, particularly by elimination of operation of the old Riverside Wastewater Treatment Plant.

(4) Reduction in the quantity of pollutants being discharged into the Trinity River at or upstream from the Village Creek confluence with the Trinity River by construction, operation, and maintenance of high quality treatment facilities operated by highly qualified plant personnel.

(5) Improvement of river water quality both upstream and downstream from the Village Creek site in order to improve recreational benefits of the river.

Construction of the facilities proposed in the 1973 engineering report, designed to properly collect and treat sewage generated through the year 1980, was origninally scheduled to be completed in July 1979. However, construction was not substantially completed until January 1981. In the meantime the Riverside WWTF was closed down and flow diverted to Village Creek WWTF in two phases, June of 1978 and January 1979. Since the required facilities were not complete, the goals of the 1973 engineering report plan were not achieved by design year 1980.

During the mid-1970's, the City realized that the 96 mgd facilities proposed in the 1973 engineering report would quickly reach capacity, and therefore submitted an application to EPA and TDWR for grant funds to conduct additional wastewater facilities planning. On 24 August 1977, EPA awarded a grant (C-48-1323) to the City of Fort Worth to assist the City in conducting facilities planning for a wastewater collection and treatment system in excess of the 96 mgd Village Creek WWTF. The City subsequently hired an engineering consulting firm, Camp Dresser and McKee, Inc. of Dallas (CDM) who formed a joint venture with Rady and Associates of Fort Worth (Rady), to prepare a new Facilities Plan and Infiltration/Inflow Analysis which would identify and plan for wastewater collection and treatment needs for the City's service area through design year 2005. Since there was a potential that new or expanded sewage treatment facilities, sludge treatment/disposal facilities, or the environmental effects of proposed facilities might extend outside of the City's existing service area, a new facilities planning area was established which included parts of Tarrant and Johnson counties. Also included in the facilities plan and EIS study area are parts of of Denton, Wise, and Ellis counties (Figure 3-2).

EPA determined that issuance of grant funds for construction of wastewater facilities would be a major Federal action with possible significant effects on the quality of the human environment. Accordingly, on 28 June 1979 EPA issued a Notice of Intent to prepare an Environmental Impact Statement (EIS). It was determined that the City would assist EPA in the preparation of this EIS concurrent with conduct of the facilities planning effort (often called a "piggyback" EIS). This Draft EIS therefore has been developed and published simultanously with the City's facilities plan. A Final EIS will be developed and published following public review of the Draft EIS, in accordance with EPA's construction grants and environmental review procedures.

3.4 NEED FOR THE PROJECT

The City of Fort Worth needs to modify its wastewater collection and treatment facilities because of the following:

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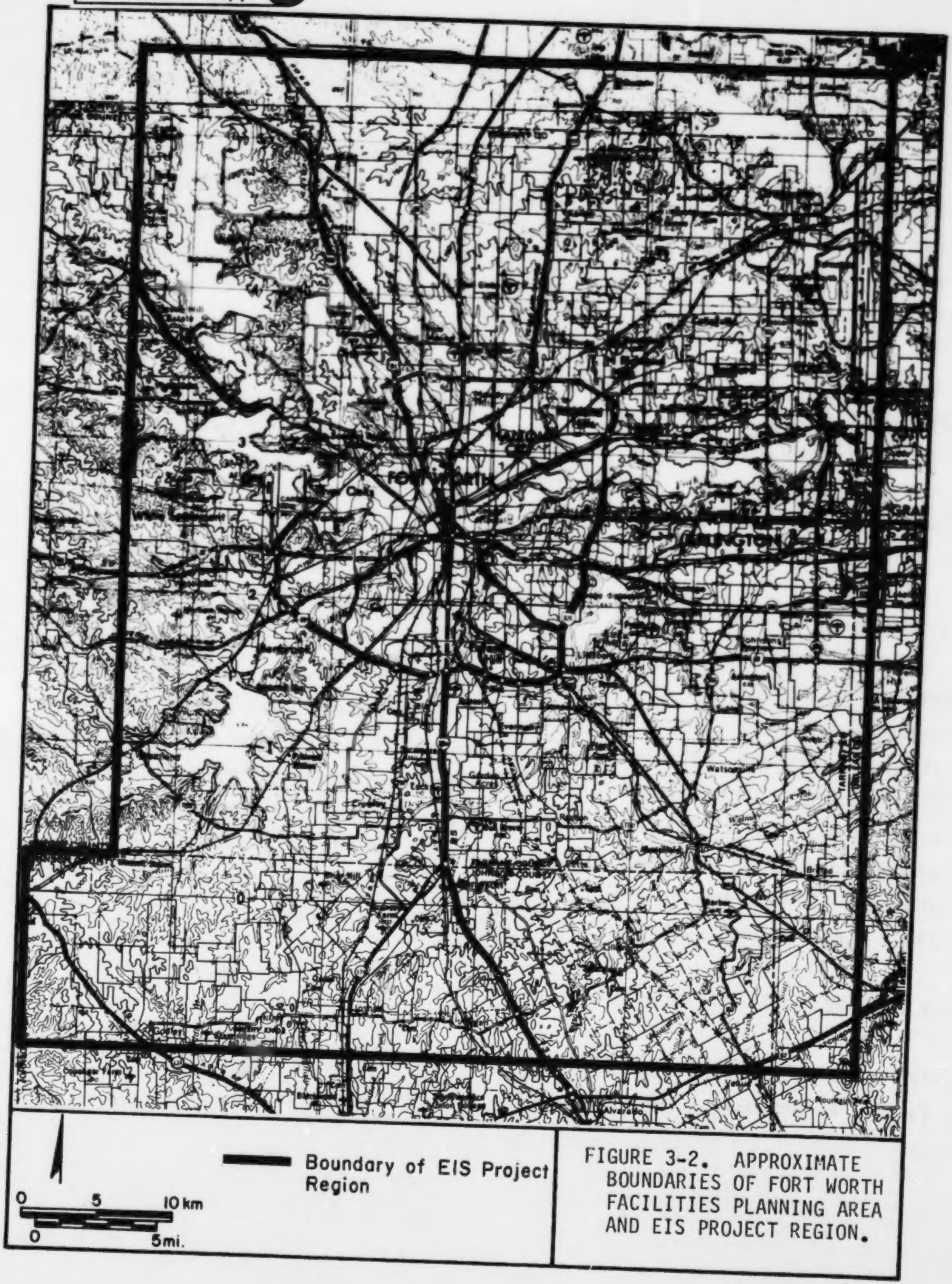

FIGURE 3-2. APPROXIMATE BOUNDARIES OF FORT WORTH FACILITIES PLANNING AREA AND EIS PROJECT REGION.

- Flows generated by continuing growth within the service area and by infiltration/inflow (I/I) during periods of wet weather periodically exceed the capacity of existing sewer trunk mains within the City's collection system. During peak flows, periodic overflows of the collection system result in discharge of raw sewage into streets and/or local streams. An I/I analysis conducted by the City determined that the I/I is not excessive; i.e., that it is not cost-effective to repair the sewers to eliminate the I/I. Therefore, new collection mains are needed to convey all sewage flows to the appropriate treatment facilities;

- The public in the vicinity of the existing Village Creek WWTF has expressed strong disapproval of odors generated by the treatment plant and/or the nearby sludge drying beds. An alternative method of dewatering sludge or for controlling odors from the present system is desired;

- New Federal regulations (40 CFR Part 257.3-6) governing application of sludge on public lands prohibit continuation of the City's practice of disposing sludge by spreading it on City parks, golf courses, and roadway rights-of-way, unless the City disinfects the sludge prior to disposal. Therefore, the City must disinfect its sludge or find alternative methods of ultimate sludge disposal;

- The existing Village Creek WWTF was designed to treat an average daily flow of 96 mgd and a peak flow of 240 mgd. These flows were anticipated to occur in design year 1980. Although actual flow rates in 1980 were slightly below anticipated levels, the plant capacity apparently will be reached by 1985. New or expanded facilities will be needed to handle the average daily flow of 137 mgd and peak flow of 464 mgd anticipated for design year 2005;

- Although the existing Village Creek WWTF was designed to handle peak flows of 2.5 times average, actual peak flows into the plant equal approximately 3.4 times average. These excessive peak flows have caused operation and maintenance difficulties in the past. The City's Riverside treatment plant was abandoned and all sewage flows diverted to the Village Creek WWTF before construction of needed improvements at the Village Creek WWTF were complete. This flow diversion and fire in the blower room caused operational difficulties at the Village Creek WWTF; and

- Dramatic increases in energy costs in recent years warrant greater emphasis on energy conservation and incorporation of efficient internal energy utilization concepts.

3.5 PURPOSE OF THE EIS

EPA determined that an EIS was necessary regarding funding of construction of wastewater facilities considered for the City of Fort Worth's wastewater management system. The EPA decision was announced in a Notice of Intent dated 28 June 1979 and published in the Federal Register. This EIS has been prepared using the "piggyback" approach whereby the environmental consequences of alternatives have been evaluated concurrently with preparation of a facilities plan.

This EIS is intended to provide information to decision makers and the general public regarding alternatives available for collection, treatment, and discharge or reuse of wastewater. The purpose of the information is to permit citizens and government officials to make an informed choice among available alternatives, so that the decisions made will be of environmental benefit.

In evaluating alternatives, the technique of cost-effectiveness analysis is used. The analysis involves comparing all alternatives in a logical, objective, and systematic manner in order to identify relative merits and deficiencies. Where possible, the comparisons are quantitative and involve the use of monetary values. The goal of the anaylsis is to identify the most cost-effective alternative, which is the alternative that:

- achieves all requirements mandated by Federal, state and local laws and regulations, including environmental requirements; and
- does so with minimum long-term cost to society; that is, with the most benefits and lowest attainable combination of dollar expenditures, environmental sacrifices, and social burdens.

While quantitative and monetary terms are used, the cost-effectiveness analysis also is partly dependent upon qualitative considerations and subjective judgments. Consequently, the results of the anlaysis are neither absolute nor fixed.

The results of the cost-effectiveness analysis are presented to the City, the CAC, the TDWR, EPA, other Federal, state, and local agencies and the general public for review and comment. Based upon the cost-effectiveness analysis and evaluation of environmental consequences presented in the Draft EIS, EPA through the TDWR will decide whether to grant funds for the City's preferred project or an alternative project pursuant to provisions of the Municipal Wastewater Treatment Construction Grant Amendments of 1981 to the Clean Water Act, and determination of the TDWR through the state priority system.

3.6 KEY ISSUES

This Draft EIS concentrates on many key issues of concern identified by EPA and the affected public during conduct of the EIS public participation program, including:

- Sources of odors and effectiveness (or lack thereof) of methods to control odors at the existing Village Creek WWTP;
- Correction of existing odor problems before any possible expansion at the existing site and assurance that new facilities would not aggravate the odor problem;
- Impacts of existing and potential future odors and insect problems on property values and tax base;
- Problems with local zoning and development encroaching on the existing plant site;
- Importance of considering altarnative methods of sludge handling and disposal with an emphasis on a system that reduces odor;
- Importance of considering all feasible wastewater management alternatives and alternatives to further expansion of the existing Village Creek WWTF (i.e., abandoning existing WWTF and developing an alternative system);
- Importance of evaluating each alternative in regard to potential impacts on:
  - water quality
  - air quality (including odors)
  - biological resources
  - socioeconomic infrastructure (including property values, land use, zoning, public services, tax base, community growth, etc.)
  - public health
  - ambient noise levels
  - recreation
- Need for project to comply with appropriate environmental laws and regulations;
- Need for all alternatives considered to be cost effective;
- Need for proposed program to be consistent with areawide water quality management planning;
- Need to enforce current regulations for operation and wastewater discharge from the existing Village Creek WWTP before any expansion plans are implemented;
- Importance of assuring an adequate level of trained operation and maintenance staff at the Village Creek WWTP; and
- Need for expanded wastewater treatment to accomodate planned growth and development.

4.0 DESCRIPTION AND EVALUATION OF ALTERNATIVES

This chapter describes and evaluates alternative methods for collecting, treating, and disposing of wastewaters generated within the Fort Worth facilities planning area. This chapter begins with a description of the City's present wastewater management system (Section 4.1). A description of the no-action alternative available to the City is presented in Section 4.2. Sections 4.3 - 4.8 describe the action alternatives for wastewater collection, treatment, and disposal evaluated by the City of Fort Worth with the assistance of the City's consultants, the CAC, and the general public. The chapter concludes with discussions of additional alternatives available to EPA, and other agencies (Sections 4.9 and 4.10, respectively).

4.1 EXISTING WASTEWATER MANAGEMENT SYSTEM

Fort Worth's wastewater management system consists primarily of two components: (1) a sewage collection system which conveys all sewage generated within the City's service area to one regional treatment facility; and (2) the Village Creek regional WWTF, a recently expanded advanced secondary treatment facility located adjacent to the confluence of the Trinity River and Village Creek in eastern Tarrant County. The City's wastewater management system is operated and administered by City staff in accordance with applicable Federal, state, and local requirements. The City's wastewater management service area does not involve any substantial areas where individual, on-site systems (e.g., septic tanks) or cluster treatment systems (e.g., multiple unit septic tanks) are utilized, nor does it involve any combined (i.e., storm water plus sanitary sewage) sewer systems. The following paragraphs briefly describe significant aspects of the City's existing collection and treatment system. Detailed information concerning these systems may be found in the infiltration/inflow analysis (CDM et al. 1980b) and draft facilities plan (CDM et al. 1983) prepared by the City's engineering consultants.

4.1.1 Existing Sewage Collection System

Sanitary sewers first were constructed in Fort Worth in 1882. Record maps prepared in 1910 indicate approximately 26 miles (mi) were installed. The system has grown steadily over the years; currently, approximately 1,645 mi of sewer ranging from 6 to 96 inches (in) diameter now comprise the Fort Worth system. An additional 1,045 mi of collection line ranging in size from 6 to 42 in diameter are located within the 21 customer communities which surround the City, thus totaling over 2,690 mi of collection lines serving the facilities planning area. A detailed discussion on Fort Worth is sewage collection system is presented in a report entitled "Report on Infiltration/Inflow Analysis for the Village Creek Wastewater Treatment Plant Facility Planning Area" (CDM et al. 1980b). Locations of major trunk mains which comprise the Fort Worth sewer collection system are illustrated in Figure 4-1.

4.1.2 Existing Wastewater Treatment System

4.1.2.1 Liquid Treatment Facilities

For twenty-two years, the City of Fort Worth operated two wastewater treatment facilities (WWTF): (1) the Riverside WWTF, located along the north bank of the Trinity River approximately 3 mi east of downtown Fort Worth; and (2) the Village Creek WWTF, located at the confluence of Village Creek and the Trinity River approximately 11.5 mi east of downtown Fort Worth (refer to Figure 4-1). A previous engineering report and an EIS, completed in 1973, proposed to expand the Village Creek WWTF to a 96 mgd capacity, and to abandon use of the Riverside WWTF. This plan was implemented, and operation of the Riverside WWTF was terminated in 1979. However, construction of the expanded Village Creek WWTF was not completed until 1981.

The Village Creek WWTF is located at the confluence of Village Creek and the Trinity River. The existing treatment plant site occupies approximately 120 acres (ac) adjacent to the Trinity River floodplain. Sludge drying beds, utilized for dewatering solids removed by the treatment process, utilize approximately 250 ac adjacent to the Trinity River floodplain and are located

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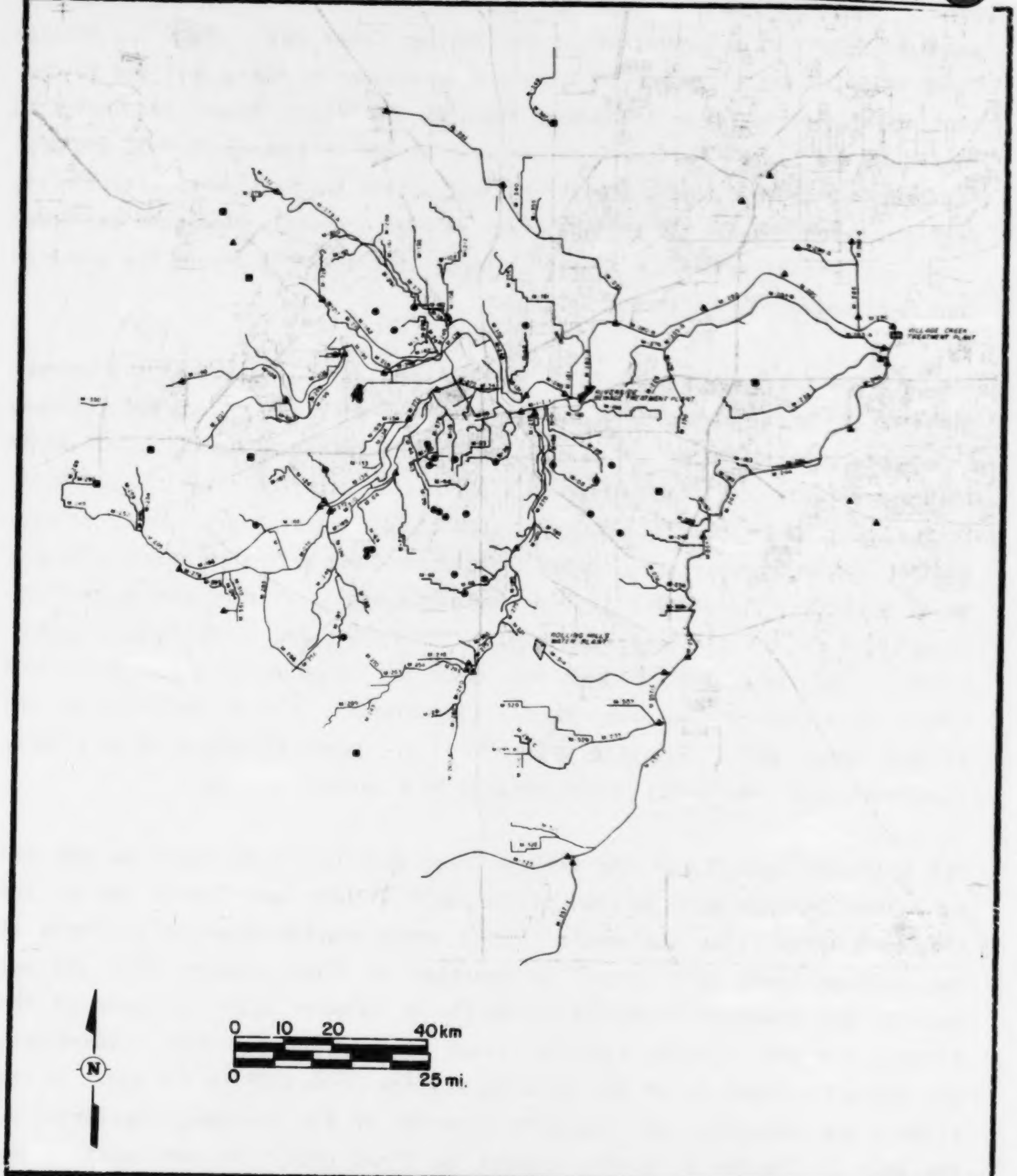
VILLAGE CREEK TREATMENT PLANT
RIVERSIDE TREATMENT PLANT
ROLLING HILLS WATER PLANT
0 10 20 40 km
0 25 mi.
N

FIGURE 4-1. CITY OF FORT WORTH SEWAGE COLLECTION SYSTEM (SOURCE: CDM et al. 1981b).

approximately 1.5 mi northeast of the Village Creek WWTF. Both the Village Creek WWTF and the sludge drying beds are surrounded by dikes designed to protect the facilities from a 100-year flood on the Trinity River. As indicated in Figure 4-2, areas to the north and west of the Village Creek WWTF and drying beds are sparsely populated areas just within the Fort Worth city limits. Just south and east of the Village Creek WWTF is a densely developed and populated residential area with expensive homes that comprise one of the prestigious developments of northwest Arlington.

The Village Creek WWTF currently is a 96 mgd advanced secondary treatment facility which contains the following treatment units: pretreatment, primary treatment, conventional activated sludge (secondary treatment), dual-media filtration (advanced treatment), and disinfection using chlorine (Figure 4-3). Solids generated by this treatment consist of: screenings, grit, primary sludge, and waste activated sludge. Screenings and grit are hauled by trucks to an existing city landfill for ultimate disposal. Primary and waste activated sludges are thickened in gravity thickeners and centrifuges, respectively. The thickened sludges are combined, anaerobically digested, and pumped to sludge drying beds located approximately 1.5 mi northeast of the Village Creek WWTF. Flotable material (e.g., scum) collected from primary clarifiers and other units is incinerated in a furnace on-site.

The hydraulic capacity of the Village Creek WWTF is the maximum flow that can be passed through each section of the WWTF without overflowing any of the treatment units. The dual-media filters which provide advanced treatment at the Village Creek WWTF cannot be operated at flows greater than 132 mgd because the pressure differential available between water surfaces at the filters and the chlorine contact basins is only about 3 feet. Therefore, the hydraulic capacity of the existing Village Creek WWTF is 132 mgd. If the filters are bypassed, the hydraulic capacity of the secondary facilities at the WWTF is limited by piping between the final clarifiers and junction box "O" to a maximum of 255 mgd (CDM et al. 1981b).

Although the Village Creek WWTF physically can pass up to 255 mgd by diversion of flow around the dual-media filters, it has not consistently been treating the flow to a level (i.e., water quality) of 10 mg/l BOD and 15 mg/l TSS. The

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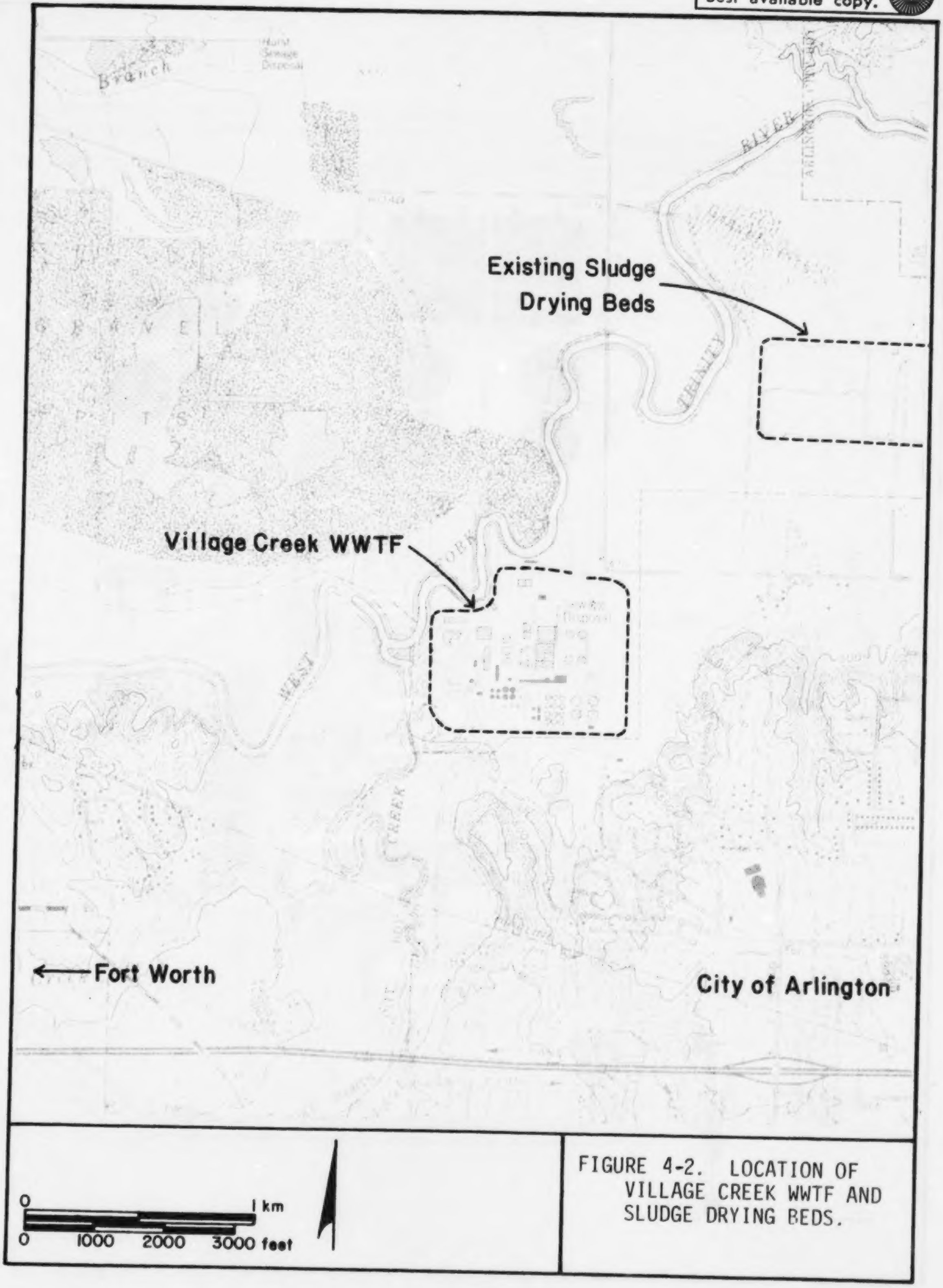

FIGURE 4-2. LOCATION OF VILLAGE CREEK WWTF AND SLUDGE DRYING BEDS.

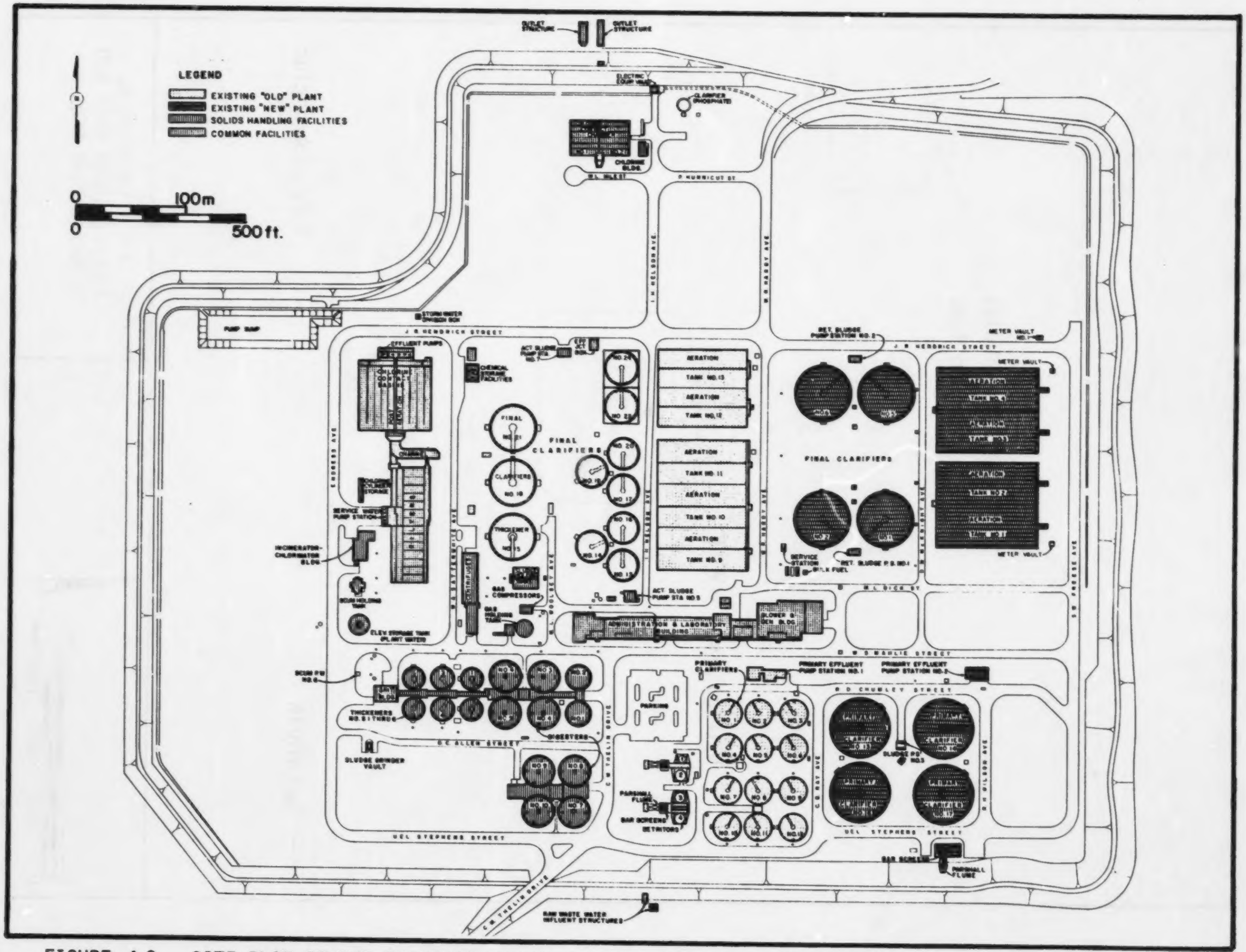

FIGURE 4-3. SITE PLAN OF THE EXISTING 96-MGD VILLAGE CREEK WWTF (SOURCE: CDM et al. 1981b).

treatment level which will be required by future state and Federal permits may be more or less stringent than this level. A treatment capacity analysis performed by CDM indicates that the present Village Creek WWTF can treat an average daily flow of 96 mgd to meet 10/10 effluent limitations. To accomplish this, however, all equipment and facilities must be in service and operating properly.

At flows greater than approximately 132 mgd, excess flow is diverted around the dual-media filters, which lowers the quality of the Village Creek WWTF effluent. At flows in excess of 180 mgd, flow is diverted around the secondary treatment units (i.e., activated sludge units) to prevent hydraulic washout, and flow which has received only primary treatment (i.e., screening and primary clarification) and chlorination is mixed with the WWTF effluent and discharged directly to the Trinity River. This diversion activity substantially reduces the quality of the Village Creek WWTF effluent. The treatment capacity analysis prepared by CDM predicts the following effluent quality for various flows with all equipment functioning properly (CDM et al. 1981b):

TYPE OF FLOW	FLOW RATE (mgd)	BOD (mg/l)	TSS (mg/l)
Average Daily Flow	96	10	10
Nominal Daily Flow	115	13	16
Maximum Daily Flow	240	47	60
Peak 2-Hour Flow	326	45	64

Table 4-1 identifies the effluent quality produced by the Village Creek WWTF (according to records of the Texas Department of Water Resources) for approximately the last 4 years. During the 46 months for which effluent data are presented, the Village Creek WWTF produced a monthly average effluent of 20/20 (which is the State of Texas minimum standard for secondary treated sewage) a total of five (5) times, and a monthly average effluent of 10/15 a total of four (4) times.

TABLE 4-1. QUALITY OF EFFLUENT PRODUCED BY THE VILLAGE CREEK WASTEWATER TREATMENT FACILITY FROM MARCH 1979 THROUGH DECEMBER 1982

DATE	FLOW (mgd)[a]	BOD (mg/l)	TSS (mg/l)
MAR 79	95.4	34	62
APR 79	125.6	37	52
MAY 79	118.3	37	59
JUN 79	94.9	28	59
JUL 79	71.7	33	66
AUG 79	80.5	29	59
SEP 79	nd[b]	nd	nd
OCT 79	62.5	25	55
NOV 79	57.1	31	57
DEC 79	64.4	61	114
9-Month Average:	85.6	35	65
JAN 80	72.5	69	117
FEB 80	76.6	53	76
MAR 80	75.9	49	98
APR 80	82.2	42	136
MAY 80	90.2	69	149
JUN 80	71.7	57	114
JUL 80	64.5	57	108
AUG 80	85.9	40	81
SEP 80	89.7	29	47
OCT 80	77.1	29	74
NOV 80	71.0	45	54
DEC 80	83.2	58	65
Yearly Average:	78.4	50	93
JAN 81	63.9	87	69
FEB 81	61.1	122	122
MAR 81	85.9	85	105
APR 81	81.8	40	31
MAY 81	90.4	47	49
JUN 81	100.4	31	49
JUL 81	85.8	26	23
AUG 81	79.4	5	5
SEP 81	82.5	11	30
OCT 81	131.3	11	40
NOV 81	110.4	5	35
DEC 81	80.5	2	6
Yearly Average:	87.8	39	47

TABLE 4-1. QUALITY OF EFFLUENT PRODUCED BY THE VILLAGE CREEK WASTEWATER TREATMENT FACILITY FROM MARCH 1979 THROUGH DECEMBER 1982 (CONCLUDED)

DATE	FLOW (mgd)[a]	BOD (mg/l)	TSS (mg/l)
JAN 82	78.7	16	72
FEB 82	97.6	27	69
MAR 82	98.7	21	70
APR 82	91.3	14	60
MAY 82	136.7	30	98
JUN 82	114.4	18	62
JUL 82	88.0	25	104
AUG 82	78.8	7	20
SEP 82	76.1	10	31
OCT 82	76.1	8	10
NOV 82	75.2	7	7
DEC 82	84.0	12	25
Yearly Average:	91.3	16	52

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a. 1.0 mgd = 0.0438 cubic meters per second (cu m/sec).

b. nd -- indicates no data available.

SOURCE: ADAPTED FROM TDWR 1982.

4.1.2.2 Sludge Treatment and Disposal Facilities

Sludge treatment and disposal facilities at the Village Creek WWTF provide for collection, treatment, and disposal of sludge (i.e., solids) produced by the wastewater treatment process. The existing sludge treatment and disposal system consists of grinders, cyclone degritters, detritors, gravity thickeners, centrifuge thickeners, anaerobic digesters, sludge drying beds, and associated pumping units. Settled sludge from primary clarifiers is removed in a dilute solution of about 1.0 percent solids so that it can be processed through sludge grinders and cyclone degritters. Grit from the cyclone degritters is conveyed to trucks for hauling and disposal at a landfill. Sludge from the cyclone degritters flows to gravity thickeners where it is thickened to approximately 4 percent solids. Modifications have been made so that thickener supernatant is recycled to the secondary treatment system. Thickened primary sludge then is pumped to anaerobic digesters.

Waste sludge from various activated sludge (i.e., aeration) tanks is collected in a holding tank and blended to produce a consistent, uniform sludge. A 1 percent solids concentration is typical in the holding tank. Waste sludge is pumped from the holding tank through screens and cyclones, and then normally pumped to centrifuges for thickening. Excess sludge which cannot be handled by centrifuges is sent to a converted clarifier which operates as a gravity thickener. The converted clarifier also can be used as a pre-thickener before the centrifuges. Thickened waste activated sludge is concentrated to about 4 to 5 percent solids and then is pumped to the anaerobic digesters along with the thickened primary sludge.

Anaerobic digesters are used to stabilize thickened sludge from the centrifuges and gravity thickeners. The Village Creek WWTF currently has high-rate gas-mixed anaerobic digesters; eight are fixed-cover digesters, and two are floating-cover digesters. Typically, detention time of at least 15 days and a digester temperature between 90°F and 95°F should be maintained to produce a well stabilized sludge and prevent odor problems. The ten digesters at the Village Creek WWTF provide a detention time of 15 days at the average flow of 96 mgd; however, at the nominal design flow rate of 115 mgd the digesters provide 12 days of digestion, assuming the same solids loading rate (CDM et al. 1983).

One advantage of anaerobic digestion is the potential recovery of digester gas for energy usage. Gas produced in the existing digesters at the Village Creek WWTF is utilized in two ways to reduce energy requirements of the WWTF. One system recirculates collected gas back into the digesters to provide mixing necessary for the digestion process. Gas not utilized in the mixing process is compressed and used as fuel for the incinerator and multi-fuel engines located within the Village Creek WWTF.

Anaerobically digested sludge then is applied to sludge drying beds for dewatering. It is important that sludge be well digested so that water will readily separate from the solids. In the present operation, liquid sludge is allowed to settle, and the supernatant is decanted and recycled to the head of the plant. This process is repeated, and the thickened solids layer is allowed to dry. Dried solids then are collected and stockpiled for use as a soil conditioner. According to the state (TDWR/TDH) guidelines for design of wastewater treatment facilities, the existing drying bed area is adequate for the amount of sludge currently produced. The drying bed system is however, subject to generation of odors caused by stagnating and standing water on the drying beds and by application of inadequately digested sludge to the drying beds. These activities have in the past created odors which have adversely affected residential areas located to the south and east of the plant. Odor masking systems (i.e., perfumes) utilized by the City at both the Village Creek WWTF and the sludge drying beds to reduce effects of odors have not been completely effective.

In summary, the present sewage collection and treatment system contains a collection line system which serves the City of Fort Worth and 21 customer communities. The collection system currently is subject to infiltration/inflow which periodically causes overflows in the system. The wastewater treatment plant is a 96 mgd plant that received an average flow of 87.8 mgd in 1981, and which potentially would receive the design flow of 96 mgd by 1985. According to state records the Village Creek WWTF met its effluent limitations only four times in the period from March 1979 to May 1982. Odors generated by the treatment plant and the associated sludge drying beds have adversely affected local residents. These events have not been satisfactory to the City; consequently, the City has developed and evaluated alternatives for future wastewater management in the facilities planning area. These alternatives are discussed in Sections 4.2 through 4.10 of this document.

4.2 NO-ACTION ALTERNATIVE

One alternative always available to the grant applicant (i.e, the City) is the "no-action" alternative. The "no-action" alternative is the alternative of not constructing any improvements to the existing Village Creek WWTF; not taking any action toward the planning, design, and construction of other treatment systems; and not implementing any other wastewater management programs. For reference purposes, it is useful to consider what would happen if the City made no improvements to their wastewater treatment facilities or to operational and administrative procedures of the present wastewater management system.

The City's sewage collection system and collection systems operated by the 21 customer communities are subject to periodic overflows of sewage into streets, drainageways, and local creeks. As growth in Fort Worth and the customer communities continues, sewage flows contributed to the collection system(s) correspondingly would increase. If the City elects to take no action, these increasing flows would cause the frequency of sewage overflows to increase substantially. Overflows would be expected to predominate along the Village Creek, Clear Fork, Big Fossil, and 72" interceptor lines (refer to Figure 4-1) since these are the collection lines whose capacities would be exceeded by large amounts (CDM et al. 1981b). Eventually, growth of Forth Worth and the customer communities would diminish and possibly stop due to lack of collection system capacity; however, sewage overflows resulting from excess flow in collection lines would continue and possibly worsen as the existing collection system's structural stability continually diminished. Such ever-increasing occurrences of raw sewage overflowing into streets, drainage ways, and local creeks would not be acceptable to the City or to the general public.

If the City selected the no action alternative, the Village Creek WWTF would remain as is. This means that certain existing treatment unit deficiencies (e.g., no grit removal prior to primary clarification, inadequate centrifuge capacity, and inadequate methane gas storage capacity) would remain. An analysis by CDM has indicated that the Village Creek WWTF can treat a design flow of 96 mgd to meet effluent limitations of 10/15 only when all treatment units are functioning efficiently. Since preventive maintenance activities and occasional equipment malfunctions would cause various treatment units to be placed out of service periodically, the plant would not consistently meet effluent limitations.

By the end of the planning period (i.e., by year 2005), virtually all treatment units at the plant would receive flow beyond their capacities. Calculations indicate that the plant would not produce an effluent better than 20/25 (BOD/TSS) under optimum conditions, and under normal conditions would produce an effluent much worse than 20/25. Since the current hydraulic capacity of the Village Creek WWTF is approximately 326 mgd, anticipated peak 2-hour flows of 466 mgd would virtually wash out (i.e., destroy) all of the biological treatment operations at the plant. Thus with no action, the Village Creek WWTF would experience continual overloading of virtually all treatment units and would discharge an average 137 mgd effluent (if the area grows as anticipated) which would be much worse than permitted effluent limitations allow. These poor treatment plant operations would not be acceptable to the City or to the general public.

Under the no action alternative, sludge treatment and disposal facilities also would be inadequate. Due to inadequate digester capacity, raw or partially digested sludge would be pumped to the sludge drying beds. Although the existing drying beds (which cover approximately 250 ac) are theoretically adequate in size to handle sludge projected for year 2005, raw or partially digested sludge applied to the sludge drying beds would not properly dry. These undried sludges would emit very objectionable odors due to degradable materials in the undigested sludge. Since additional volumes of undigested sludge would continually overload the anaerobic digesters, partially dried sludge would be removed from the drying beds to make room for applying new sludge from the overloaded digesters. Partially dried sludge from the drying beds would then be temporarily stockpiled, and hauled to refuse landfills as soon as possible. Utilization of sludge as a soil conditioner by state, municipal, and private personnel would not continue due to the unacceptable condition (e.g., wet, decaying, and odorous) of the sludge. These malodorous sludge operations would not be acceptable to the City or to the general public.

4.3 PLANNING AND DESIGN INFORMATION APPLICABLE TO ALL ACTION ALTERNATIVES

Action alternatives were developed for treatment and disposal of the City's wastewater (including both liquid wastes and sludge) to conform to the objective of meeting stream standards for the West Fork of the Trinity River. Much of the planning information for the action alternatives is the same for all alternatives evaluated. For example, the planning period is the same, the total wastewater flow to be treated is constant, and the effluent limitations applicable to wastewater discharges remains the same. Other planning information, such as the type of biological treatment units and methods of sludge treatment and disposal to be utilized can vary with each alternative. This section discusses planning information applicable to all alternatives evaluated by the City.

4.3.1 Population Projections and Planning Period

Construction of the existing 96 mgd Village Creek WWTF was completed in 1981. As indicated previously in Table 4-1, average flow at the Village Creek WWTF was 78.4 mgd in 1980, 87.8 mgd in 1981, and 91.3 mgd in 1982. Thus existing capacity at the 96 mgd Village Creek WWTF quickly is being approached. Studies by the City's engineering consultants indicated that the average daily flow of 96 mgd could be reached on a continous basis by year 1985. Since facilities planning typically is conducted for a 20 year planning period, for the purposes of this project the planning period was established as 1985 to 2005.

Facilities plans within Texas must be developed based upon official population projections approved by the state. Official state projections are dissagregated for designated planning regions within the state by regional planning organizations. The areawide planning agency for this project region is the

North Central Texas Council of Governments (NCTCOG). For this project, the City and NCTCOG held several meetings in 1979 and jointly developed population projections, by watershed, for the Fort Worth facilities planning area (Table 4-2). As indicated in Table 4-2, some people in the planning area would not receive sewer service. Persons in some watersheds currently are served by individual sewerage systems (i.e., septic tanks), and would continue to be served by such individual systems through year 2005. Table 4-2 indicates total persons projected to be in the facilities planning area and persons to be served for the years 1980, 1990, and 2000 as determined by the City's engineering consultants. Since the planning period is 1985-2005, projections for years 1985, 1995, and 2005 were made using straight line projections in order to provide planning information appropriate to the beginning and end of the planning period (Table 4-3). These projections have been used exclusively by the City and the City's engineering consultants in developing the Fort Worth draft facilities plan.

In 1980, the NCTCOG published a revised set of population projections for the facilities planning area. These revised projections, based upon the 1980 Census, are presented in Table 4-4. Although substantial differences were evident for specific watersheds, the overall change in the projected population for the facilities planning area decreased only 3 percent for year 1990, and decreased only 7 percent for year 2000. The City concluded that these decreases were minimal and well within an acceptable accuracy range for facilities planning efforts. Accordingly, no adjustments were made to the design year 2005 projected population of 1,040,000.

In December 1982, the NCTCOG again revised population projections for the Fort Worth facilities planning area (Hicks 1982). The NCTCOG's projections were made for years 1980, 1990 and 2000. Table 4-5 is a comparison of the City's original projections and NCTCOG's revised projections, interpolated for years 1985, 1995 and 2005. Final population figures for the design year (2005) are currently being negotiated and have yet to be approved by the TDWR. The City has decided not to incorporate new population projections in the draft facilities plan until the design year population projection is finalized. If there is a difference between the final design year population projection and the population projection used in the facilities plan, then the TDWR simply will pro-rate a construction grant award (if any) accordingly (Lock 1983).

TABLE 4-2. POPULATION PROJECTIONS INITIALLY DEVELOPED IN 1979 BY THE CITY AND NCTCOG FOR USE IN THE FORT WORTH FACILITIES PLAN

Watershed No.	Name	1975	1980			1990			2000			2030		
		Watershed Population	Watershed Population (A)	% Watershed Served	Population Served (B)	Watershed Population	% Watershed Served	Population Served	Watershed Population (C)	% Watershed Served	Population Served (B)	Watershed Population	% Watershed Served	Population Served (B)
009	West Fork Above Mountain Dr.	42,845	53,598	7	1,800	61,200	7	3,000	70,000	7	3,900		7	4,700
010	West Fork Above Vill. Cr.	29,036	32,705	100	32,700	45,000	100	45,000	48,000	100	48,000		100	57,000
011	West Fork Above Sycamore Cr.	29,591	26,511	100	26,500	31,000	100	31,000	31,700	100	31,700		100	36,000
012	West Fork Above Clear Fork	38,210	38,758	100	38,700	41,700	100	41,700	43,000	100	43,000		100	51,000
013	Lake Worth Dam	14,212	14,160	19	6,000	30,000	62	17,000	40,000	86	35,000		86	42,000
081	Walnut Creek	8,001	9,473	0	0	12,400	10	1,800	18,000	20	3,500		20	3,600
087	Walker Branch	66,968	74,629	77	54,000	83,600	80	77,000	96,000	80	80,000		80	99,000
088	Village Creek	25,007	27,309	86	22,000	40,000	86	38,000	47,000	86	42,000		86	50,000
089	Lake Arlington Dam	39,049	42,745	97	40,000	60,000	100	60,000	63,000	100	63,000		100	75,000
090	Middle Village Creek	17,290	23,937	61	15,000	30,000	85	26,500	33,000	100	33,000		100	39,600
091	Upper Village Creek	14,547	14,500	19	14,500	16,000	20	15,000	40,000	22	30,000		22	36,000
092	Rush Creek	32,699	39,992	78	35,000	55,000	85	48,500	60,000	100	60,000		100	72,000
093	Dear Creek	4,908	6,397	50	4,000	16,000	67	15,000	18,000	100	18,000		100	21,600
094	Big Fossil Creek	27,267	31,321	33	29,000	43,000	60	40,000	51,000	90	49,000		90	65,000
095	Lower Little Fossil Creek	18,517	18,518	100	18,500	25,000	100	25,000	25,000	100	25,000		100	30,000
096	Upper Little Fossil Creek	5,309	5,978	98	5,000	6,000	100	6,000	6,000	100	6,000		100	10,000
097	Dry Branch	6,251	6,650	100	6,600	7,000	100	7,000	7,500	100	7,500		100	8,500
098	Lower Sycamore Creek	70,524	70,013	100	70,000	74,000	100	74,000	75,000	100	75,000		100	90,000
099	Upper Sycamore Creek	25,767	39,612	70	34,000	40,000	100	40,000	43,000	100	43,000		100	51,000
100	Sycamore Tributary	9,434	9,470	100	9,000	9,700	100	9,700	10,000	100	10,000		100	12,000
101	Marine Creek	20,011	22,193	79	18,000	35,000	100	35,000	38,000	100	38,000		100	45,000
102	Clear Fork Trinity River	110,631	114,500	100	114,500	135,000	100	135,000	145,000	100	145,000		100	165,000
103	Benbrook Lake Dam	2,183	2,932	1	300	10,000	5	1,000	26,000	10	13,000		10	15,600
104	Mary's Creek	21,401	25,081	51	18,000	40,000	85	34,500	45,000	100	45,000		100	54,000
106	Kings Branch	21,099	26,865	97	25,000	32,400	100	32,400	34,200	100	34,200		100	41,000
107	East Eagle Mountain Lake	915	883	5	1,000(D)	3,100	40	2,000	4,500	100	4,500		100	5,400
	TOTAL	701,672	778,730		639,100	982,100		861,100	1,117,900		985,800			1,180,000

(A) NCTCOG Estimate.
(B) CDM/Rady Estimate. Population is in the watershed, in the Facility Plan boundary, and in the anticipated service area.
(C) Fort Worth Estimate. NCTCOG concurs.
(D) From Regional Area Analysis, the majority of populace in Fort Worth Municipal District #1.

SOURCE: CDM et al. 1981a.

TABLE 4-3. PROJECTIONS OF TOTAL POPULATION AND POPULATION TO BE SERVED BY TREATMENT FACILITIES WITHIN THE FACILITIES PLANNING AREA AS DETERMINED BY THE CITY AND UTILIZED EXCLUSIVELY FOR FACILITIES PLANNING

Design Year	Total Area Population	% of Watershed To Be Served By Treatment Facilities	Design Population To Be Served By Treatment Facilities
1980	778,730	82	639,100
1985	880,415[a]	85[a]	750,100[a]
1990	982,100	88	861,100
1995	1,050,000[a]	88[a]	923,450[a]
2000	1,117,900	88	985,800
2005	1,185,800[a]	88[a]	1,040,000

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a. Indicates an interpolated value.

SOURCE: ADAPTED FROM CDM et al. 1981b.

TABLE 4-4. COMPARISON OF POPULATION PROJECTIONS (DEVELOPED IN 1979) USED FOR FACILITIES PLANNING, AND REVISED PROJECTIONS ISSUED BY NCTCOG IN 1980

Water-Shed No.	Name	CDM	NCTCOG	DIFFERENCE	CDM	NCTCOG	DIFFERENCE
009	West Fork Above Mountain Dr.	61,200	80,064	31%	70,000	90,013	29%
010	West Fork Above Vill. Creek	45,000	36,182	-20%	48,000	41,164	-14%
011	West Fork Above Sycamore Cr.	31,000	28,125	- 9%	31,700	28/799	- 9%
012	West Fork Above Clear Fork	41,700	38,876	- 7%	43,000	40,242	- 7%
013	Lake Worth Dam	30,000	16,987	-43%	40,000	19,198	-52%
081	Walnut Creek	12,400	15,208	23%	18,000	17,000	23%
087	Walker Branch	83,600	86,096	3%	96,00	91,934	- 4%
088	Village Creek	40,000	41,400	4%	47,000	44,200	- 6%
089	Lake Arlington Dam	60,000	50,761	-15%	63,000	55,087	-13%
090	Middle Village Creek	30,000	23,449	-22%	33,000	27,369	-22%
091	Upper Village Creek	16,000	25,325	58%	40,000	26,999	-33%
092	Rush Creek	55,000	92,116	67%	60,000	95,827	60%
093	Dear Creek	16,000	12,620	-21%	18,000	18,277	2%
094	Big Fossil Creek	43,000	48,306	12%	51,000	57,455	13%
095	Lower Little Fossil Creek	25,000	18,271	-27%	25,000	18,888	-24%
096	Upper Little Fossil Creek	6,000	12,440	107%	6,000	14,148	236%
097	Dry Branch	7,000	6,543	- 7%	7,500	6,849	- 9%
098	Lower Sycamore Creek	74,000	69,966	- 5%	75,000	71,239	- 5%
099	Upper Sycamore Creek	40,000	32,759	-18%	43,000	37,863	-12%
100	Sycamore Tributary	9,700	7,320	-24%	10,000	7,743	-23%
101	Marine Creek	35,000	23,550	-33%	38,000	26,156	-31%
102	Clear Fork Trinity River	135,000	124,011	- 8%	145,000	130,576	-10%
103	Benbrook Lake Dam	10,000	8,447	-15%	26,000	9,892	-62%
104	Mary's Creek	40,000	27,802	-30%	45,000	31,851	-30%
106	Kings Branch	32,400	23,229	-28%	34,200	25,149	-26%
107	East Eagle Mountain Lake	3,100	1,450	-53%	4,500	1,595	-65%
	TOTALS	982,100	951,303	- 3%	1,117,900	1,035,513	- 7%

TABLE 4-5. A COMPARISION OF THE POPULATION PROJECTIONS USED BY THE CITY FOR FACILITIES PLANNING AND RECENT PROJECTIONS ISSUED BY THE NORTH CENTRAL COUNCIL OF GOVERNMENTS

Design Year	Projections Used By The City			Official Projections By NCTCOG			Difference in Design Populations
	Total Watershed	% Served	Design Population	Total Watershed	% Served	Design Population[b]	
1980	778,730	82	639,100	702,388	82	575,958	11%
1985[a]	880,415	85	750,100	747,523	85	635,395	18%
1990	982,100	88	861,100	792,657	88	697,538	23%
1995[a]	1,050,000	88	923,450	837,706	88	737,181	25%
2000	1,117,900	88	985,800	882,755	88	776,824	27%
2005[a]	1,185,800	88	1,040,000	927,804	88	816,468	27%

a. Values for these years interpolated.

b. Calculated using same "% served" values.

SOURCE: 1. ADAPTED FROM CDM et al. 1983.
2. HICKS 1983

4.3.2 Flow and Wasteload Reduction

A design year population such as that discussed previously typically is utilized to determine sewage flow that would be generated by persons within a service area, including flows generated by commercial and industrial facilities. However, before a design flow can be determined, other flows and/or wasteloads must be evaluated to document that treatment facilities would not be treating extraneous flows or pollutants that should not be in the sewerage system in the first place. Elimination or reduction of extraneous wastewater flows and wasteloads can substantially reduce the size and costs of new or expanded treatment facilities. Possible elimination or reduction of extraneous flows and wasteloads in the following categories are evaluated as part of the following analysis: infiltration/inflow; industrial loadings; and water conservation measurers.

4.3.2.1 Infiltration/Inflow Reduction

Infiltration/Inflow (I/I) basically is extraneous rainwater and/or groundwater that finds its way into sewage collection lines. Infiltration consists primarily of groundwater that seeps through loose pipe joints or cracked pipes into sewers, either continuously or over a long duration during and following wet weather. Inflow consists primarily of rainwater that enters sewers through direct connections (e.g., open manholes in drainageways or roof drains illegally connected to the sewer).

In 1978, EPA awarded to the City a construction grant to perform an I/I analysis as part of the facilities plan. Construction grant regulations in effect at that time required all grantees applying for construction grants to perform an I/I analysis. In accordance with this regulation, the City performed an I/I analysis and submitted a report entitled "Infiltration/Inflow Analysis for the Village Creek Wastewater Treatment Plant Facility Planning Area" in December 1980. This report concluded that I/I is non-excessive, and no sewer system evaluation survey is needed. The TDWR formally approved the I/I analysis and its conclusions on 19 May 1981 (CDM et al. 1983).

EPA's recent construction grants guidelines (USEPA 1982b) suggest that infiltration is excessive if measured flows during high groundwater periods exceed 120 gallons per capita per day (gpcd) (assumed to be 70 gpcd domestic wastewater and 50 gpcd infiltration). Inflow potentially is excessive if peak flows during rainfall exceed 2.5 times the average design flow of the plant. In 1980, when approximately 639,100 persons were served by the City's sewerage system, plant flows during high groundwater periods were measured at approximately 70 mgd (CDM et al. 1980b), which equates to 70 mgd/639,100 = 110 gpcd. Thus, according to these flow measurements, infiltration within the Fort Worth system would not be excessive. Record peak flows entering the Village Creek WWTF were measured at 217 mgd on 30 March 1979, but probably would have measured 283 mgd if flow limiting conditions had not been present at the plant (CDM et al. 1981b). When compared to the existing Village Creek WWTF design flow of 96 mgd, the ratio of estimated peak flow to average daily flow is 283 mgd/96 mgd = 2.95, which is greater than 2.5. This would indicate that inflow potentially could be excessive according to EPA's "rule of thumb" guidelines.

By definition, I/I is "excessive" if it can be located and eliminated cheaper than it can be treated. The final I/I analysis determined that the Fort Worth collection system is subjected to approximately 8 mgd of infiltration and 13 mgd of inflow. However, the report also determined that locating and repairing the sources of extraneous flow (e.g., broken pipes and improper connections) would be much more expensive than the cost of treating the flows at the Village Creek WWTF (CDM et al. 1980b). Thus, the I/I analysis concluded that extraneous flows in the City's system are non-excessive and should continue to be treated at the Village Creek WWTF. The I/I analysis also projected that non-excessive I/I flows in design year 2005 would consist of 11 mgd infiltration and 18 mgd inflow. Thus it was determined that 29 mgd of I/I would be included when establishing the total design flow for year 2005.

4.3.2.2 Industrial Loading

In addition to flow, the "strength" of sewage (i.e., the weight of pollutants per volume of wastewater) also greatly affects the size and cost of sewage treatment processes. Average residential sewage flows typically have organic loadings, or sewage strengths, in the range of 200 mg/l to 300 mg/l of 5-day biochemical oxygen demand (BOD). Some industries in Fort Worth currently discharge sewage with much more strength than typical residential sewage. For example, as shown in Table 4-6, the Miller Brewing Company discharges approximately 67.14 million gallons of wastewater per month (or 2.2 mgd) that has an average BOD of 1,549 mg/l (CDM et al. 1983), which is equivalent to 11.8 mgd of residential sewage with a BOD of 295 mg/l. To be aware of and potentially control such industrial discharges, the City of Fort Worth has an Industrial Pretreatment and Monitoring Program (City Ordinance No. 8158) which became effective on 1 October 1980. The City currently monitors 101 industries for compliance with requirements of the industrial ordinance. The ordinance requires all facilities that discharge wastewater from commercial and industrial processes to have a permit. The ordinance also allows the director of the water department to monitor industrial discharges and, if excessive or abnormally high or low strength wastewaters are being discharged, the director can assess additional financial charges or require pretreatment of the wastewater.

In addition, the ordinance strictly prohibits discharge of certain stormwaters, high temperature wastes, greases and waxes, flammable materials, solids, unshredded garbage, oils, acids, heavy metals, toxic compounds, radioactive materials, or other materials in excess of limits established in the ordinance that could damage collection lines or could be detrimental to sewage treatment processes.

Currently, the City typically assesses additional charges on industries discharging high strength wastes, in lieu of requiring industries to pretreat wastes to remove compatible pollutants such as BOD and TSS. Discharge of other pollutants limited by the industrial ordinance are strictly prohibited. EPA's construction grants regulations regarding transport and treatment of compatible industrial wastewaters state:

> "(a) Grant assistance shall be provided for treatment works capacity to transport or treat compatible industrial wastewater, only if the treatment works (including each collector, interceptor, pumping station, plant component, and other system component) would be eligible for grant assistance in the absence of the industrial capacity" (USEPA 1982b).

TABLE 4-6. EXAMPLES OF SELECTED INDUSTRIES IN THE FORT WORTH FACILITIES PLANNING AREA THAT DISCHARGE WASTEWATER CONTAINING POLLUTANTS IN MUCH GREATER QUANTITIES THAN TYPICAL RESIDENTIAL SEWAGE

Industry Name	Type or Product	Monthly Flow (mgal)	BOD (mg/l)	Flow Equivalent BOD = 295 mg/l (mgd)
Bunge Corp.	Mfg. Lard - Edible Oils	10.78	3,481	4.2
Miller Brewing Co.	Beer Brewery	67.14	1,549	11.8
Coca Cola Can.	Soft Drink Mfg.	2.50	3,897	1.1
National Can Corp.	Mfg. Metal Cans	6.93	3,997	3.1
Standard Meat Co.	Red Meat Processing	4.30	2,099	1.0
Waples Platter	Canned Fruits, Preserves	4.40	2,398	1.2
Wommack Grease	Grease Rendering	0.65	24,883	1.8

SOURCE: ADAPTED FROM CDM et al. 1983.

In other words, EPA generally would fund collection and treatment facilities needed for treating residential sewage, but would not fund additional treatment units or bigger units required to treat high strength industrial flows that could as easily be eliminated by industrial pretreatment.

A brief evaluation of industrial wastewater monitoring information indicates that as much as 30 to 40 percent of the BOD loading treated by the existing 96 mgd Village Creek WWTF potentially is generated by industries. A detailed analysis of which additional collection and treatment facilities (if any) are currently required to treat these compatible industrial pollutants is not available. However, it is evident that the City does monitor generation of excessive industrial loadings and does prohibit discharge of non-compatible industrial wastewaters.

4.3.2.3 Water Conservation Measures

The size and costs of various collection and treatment facilities also can be substantially reduced by incorporating various water conservation measures that result in reduced wastewater discharges. EPA considers flows of 70 gpcd for domestic sewage and 50 gpcd of I/I as typical. The value of 70 gpcd for domestic sewage is a national average, and per capita flows substantially higher sometimes indicate wasteful conditions. EPA guidelines issued in mid-1982 indicate that flows of 65 to 80 gpcd are acceptable for large cities with moderate industrial development (USEPA 1982b). The City's average daily base flow (i.e., without I/I) in 1980 of 62 mgd contributed by 639,100 persons yields a per capita flow of 97.8 gpcd. Since this flow is greater than 70 or 80 gpcd, it is feasible that water conservation measures might potentially be cost-effective to implement in the facilities planning area.

Clean water has for many years often been regarded as one of the nation's bountiful free goods. Concerns over water supply and wastewater disposal and an increasing recognition of the benefits that may accrue through water conservation are serving to greatly stimulate development and application of water conservation practices. The diverse array of water conservation practices may, in general, be divided into these major categories:

- Elimination of non-functional water use;
- Water-saving devices, fixtures, and appliances; and
- Wastewater recycle/reuse systems.

Elimination of Non-functional Water Use. Non-functional water use typically is the result of the following:

- Wasteful, water-use habits such as flushing a toilet to dispose of a cigarette butt, allowing water to run while brushing teeth or shaving, or operating a clotheswasher or dishwasher with only a partial load;
- Excessive water supply pressure - for most dwellings a water supply pressure of 40 pounds per square inch (psi) is adequate. Pressure in excess of this can result in unnecessary water-use and wastewater generation, especially with wasteful water-use habits; and
- Inadequate plumbing and appliance maintenance - unseen or apparently insignificant leaks from household fixtures and appliances can waste large volumes of water and generate similar quantities of wastewater. Most notable in this regard are leaking toilets and dripping faucets. For example, even a pinhole leak which may appear as a dripping faucet can waste up to 170 gal/day at a pressure of 40 psi. This is equivalent to the amount of wastewater discharged by 2.4 persons per day. More severe leaks can generate even more massive quantities of wastewater.

Water-Saving Devices, Fixtures, and Appliances. The quantity of water traditionally used by given household fixtures or appliances often is considerably greater than actually necessary. Typically, toilet flushing, bathing, and clotheswashing collectively account for over 70 percent of a household's interior water use and waste flow volume (Siegrist et al. 1978). Thus, efforts to accomplish major reductions in wastewater flow volume, as well as its pollutant mass, have been directed toward toilet flushing, bathing, and clotheswashing facilities. Some selected water conservation/wasteload reduction devices and systems developed for household use are:

- Toilet devices and systems
    - Toilet tank inserts - such as water filled and weighted plastic bottles, bricks, flexible panels, and/or dams
    - Dual-flush toilet devices
    - Shallow-trap toilets
    - Very low volume flush toilets
    - Non-water carriage toilets

- Bathing devices and systems
  - Shower flow control devices
  - Reduced-flow shower fixtures

- Clotheswashing devices and systems

  Waste flow reductions may be accomplished through use of a clotheswasher with a suds-saver attachment. The suds-saver feature is included as an optional cycle setting on several commercially made washers. The selection of a suds-saver cycle when washing provides for storage of the washwater from the wash cycle for subsequent use as the wash water for the next wash load. The rinse cycle remains unchanged.

Wastewater Recycle/Reuse Systems. These systems provide for collection and processing of all household wastewater, or fractions produced by certain activities, for subsequent reuse. A system which has received a majority of development efforts includes recycling bathing and laundry wastewater for flushing toilets and/or outside irrigation.

Wastewater flow reduction on the order of 15 to 30 gpcd can be achieved by installing combinations of the following devices and systems:

- Replace standard toilets with dual cycle or other low volume toilets;
- Reduce shower water use by installing thermostatic mixing valves and flow control shower heads. Use of showers should be encouraged rather than baths whenever possible;
- Replace older clotheswashing machines with those equipped with water-level controls or with front-loading machines;
- Use recycled bath and laundry wastewaters to sprinkle lawns in summer;
- Recycle bath and laundry wastewaters for toilet flushing. Filtering and disinfection of bath and laundry wastes for this purpose has been shown to be feasible and aesthetically acceptable in pilot studies (Cohen et al. 1974; McLaughlin 1968); and
- Commercially available pressurized toilets and air-assisted shower heads, using a common air compressor of small horsepower, reduce sewage volume from these two largest household sources up to 90 percent.

Other Water Conservation Measures. Another possible method for reduction of sewage flow is adjustment of the price of water to control consumption. This method normally is used to reduce water demand in areas with water shortages. However, it probably would not be effective in reducing sanitary sewer flows because much of its impact is usually on luxury water usage, such as lawn sprinkling and car washing. None of these luxury uses imposes a load on a sewerage system. Therefore, use of price controls probably would not be effective in significantly reducing wastewater flows.

Other measures include educational campaigns on water conservation in everyday living, and installation of pressure-reduction valves in areas where water pressure is excessive (greater than 60 psi). Educational campaigns usually take the form of spot television and radio commercials, and distribution of leaflets with water and sewer bills. Water saving devices must continue to be used and maintained for flow reduction to be effective. City ordinances requiring water saving devices, fixtures, and appliances in commercial establishments (e.g., hotels and motels) and all new residential construction also can be effective.

Impact of Water Conservation Measures on Wastewater Treatment Systems. Methods that reduce flow or pollutant loads can provide the following benefits to a wastewater management program:

- Reduce the size and capital cost of new sewage collection and treatment facilities;
- Delay the time when future expansion or replacement facilities would be needed;
- Reduce operational costs of pumping and treatment; and
- Mitigate sludge and effluent disposal impacts.

To reduce wasteloads (flow volume and/or pollutant contributions) generated by a typical household, an extensive array of techniques, devices, and systems are available. If water conservation measures were utilized to reduce per capita flows from 97.8 gpcd to 80 gpcd, domestic flows generated by the 639,100 persons served in the facilities planning area in 1980 would be reduced from 62 mgd to 51 mgd. Similarly, domestic flows expected to be generated by 1,040,000 persons in 2005 would be reduced from 102 mgd to 83 mgd.

The effectiveness of water conservation is complex and must be determined on a case-by-case basis. The City evaluated water conservation measures for the facilities planning area. Flow reduction measures considered by the City and the City's subsequent conclusions regarding water conservation included:

- A public information program to encourage wastewater reduction: this is practiced by the City in the form of enclosures with water and sewer bills;

- Changes in water pricing policies to promote conservation: Fort Worth presently has a pricing system that pays for the entire system and that is responsive to the volume of water consumed and wastewater produced by the individual user. As consumption increases the customer cost increases;

- Installing water meters and retrofitting existing homes with water saving devices: Fort Worth, and all of the customer cities use water meters to measure water consumption and estimate sewage production. Monthly charges for both water and sewer services are based on the volume of water used. The retrofitting of existing homes with water saving devices can cost from $10 to $150 per customer, and could be expected to reduce wastewater production by 4-6 percent of the volume. There would be no reduction in the pollutants produced, nor would there be a measurable reduction in peak or maximum day flows. The peak and maximum day flows are critical in determining the sizing of processes at the Village Creek WWTF. Thus, even with a reduction of volume due to water saving devices, the size of the plant, and therefore the construction cost, remains unchanged. Operation and maintenance costs are dependent on two principle factors: the size of the plant and the mass of pollutants received at the plant. Since neither the size of the plant nor the mass of pollutants provided in the system is changed due to the retrofitting existing homes with water saving devices, there are no resulting (O&M or construction) cost savings that can be counted on at the Village Creek WWTF. Thus, there are no monetary benefits associated with retrofitting existing homes at a cost, to the City, of $2.4 to 3.6 million. A retrofit program may eventually be justified for other reasons (such as water conservation or political); and

- Changes in local ordinances or codes that require installing water saving devices in new construction: Similar to retrofitting, requiring the installation of water saving devices is not economically justified on purely wastewater reduction grounds.

However, the City does recognize that implementation of conservation measures at a future time could reduce flows and could extend the design capacity of collection and treatment facilities (CDM 1983c).

4.3.3 Flow and Wasteload Characteristics

Once population projections were made and various flow and wasteload reduction measures were evaluated for applicability to this project, then design flow and wasteload characteristics were determined. Design flows were established for average base flow, average daily flow, maximum daily flow, and peak 2 hour flow. These flows, using the methodology established in the facilities plan, consist of the following factors:

- Base Flow: Consists of residential, commercial, and industrial flows only. This flow is calculated by multiplying a per capita domestic flow by the design year population;
- Average Daily Flow: This flow consists of the base flow plus non-excessive I/I;
- Maximum Daily Flow: This flow is determined by multiplying the average daily flow (including I/I) by a maximum day peaking factor of 2.50; and
- Peak 2-Hour Flow: This flow is determined by multiplying the maximum daily flow (including I/I) by a peaking factor of 1.36.

It is noted that, when using the above methodology, peaking factors were applied to the I/I portions of daily flows. Peaking factors were determined by comparing annual average daily flows with maximum daily flows and peak flow rates. The average flows, maximum flows and peak flow rates were determined in accordance with chapter 3.0 of EPA Manual - "Handbook for Sewer System Evaluation and Rehabilitation" (CDM 1983c).

Several design flows can be calculated for the facilities planning area, depending on which population projection (i.e., the City's or NCTCOG's) and which per capita flow is utilized. Table 4-7 illustrates the results of determining an average design flow using these various factors. As illustrated, design flows vary widely based upon the criteria utilized. All facilities planning efforts conducted by the City have utilized criteria listed as No. 5. A complete breakdown of estimated flows utilized by the City for facilities planning for various years from 1980 through design year 2005 is presented in Table 4-8.

TABLE 4-7. RANGE OF DESIGN FLOWS FOR THE FACILITIES PLANNING AREA WHICH CAN BE DETERMINED USING VARIOUS DESIGN CRITERIA

No.	Design Year	Design Population	Per Capita Flow (gpcd)	Average Daily Base Flow (mgd)	Infiltration/Inflow		Average Daily Flow (mgd)
					Infiltration (mgd)	Inflow (mgd)	
1.	2005	816,468[a]	80.0[b]	65	11	18	94
2.	2005	816,468	97.8[c]	80	11	18	109
3.	2005	1,040,000[d]	80.0	83	11	18	112
4.	2005	1,040,000	97.8	102	11	18	131
5.	2005	1,040,000	103.9[e]	108	11	18	137

a. Population estimate established by NCTCOG in 1981.

b. Per capita flow guidelines established by EPA in 1982, if wastewater flow records are inadequate.

c. Per capita flow established by Fort Worth I/I evaluation.

d. Population estimate originally established by City and NCTCOG in 1979.

e. Per capita flow established by City to include a 5% growth in industrial flows.

TABLE 4-8. DESIGN FLOWS DETERMINED BY THE CITY OF FORT WORTH AND UTILIZED THROUGHOUT THE FACILITIES PLANNING EFFORT.

Year	Population Served	Average Day Day Flow (MGD)	Average Infiltration/ Inflow (I/I)		Avg. Daily Flow = Dry and I/I (MGD)	Max. Day Flow = 2.5 x Avg. Daily Flow (MGD)	Inflow on Max. Flow Day (MGD)	Peak 2 hr. Flow Rate =1.36 x Max. Day Flow (MGD)
			Infilt. (MGD)	Inflow (MGD)				
1980	639,000	62 (97.8 gpcd)	8	13	83 (129.9 gpcd)	208	138	283
1990	861,000	84 (97.8 gpcd)	9	16	109 (126.6 gpcd)	273	180	371
2000	986,000	96	10	17	123	308	202	419
2005	1,040,000	102 (97.8 gpcd)	10.5	17.5	130 (125.0 gpcd)	325	213	442
2005*	1,040,000	108	11	18	137	341	224	464

*With 5% Allowance for Unannounced Industrial Growth

SOURCE: CDM et al. 1983.

Wasteload characteristics were developed using data from laboratory analyses of Village Creek WWTF raw sewage influent and of sludge currently produced at the plant, and by using good engineering judgement. Table 4-9 lists characteristics of raw sewage influent to the Village Creek WWTF. These characteristics are not expected to change drastically over the planning period due to the fact that excessive discharges of non-compatible pollutants (e.g., heavy metals) are restricted by the City's existing Industrial Pretreatment Ordinance; thus, pollutants present in the raw sewage influent in design year 2005 should be basically as they are today. Therefore, all wastewater to be treated in year 2005 is expected by the City to have the characteristics (e.g., flow and wasteloads) listed in Table 4-9.

4.3.4 Effluent Limitations

The quality of effluent (i.e., degree of treatment) which must be produced by the Village Creek WWTF is listed in wastewater discharge permits issued by the state and/or EPA. Discharge permits normally are issued for a 5 year term. Two permits have been issued to the City within the last 10 or so years. EPA's NPDES Permit Number TX 0047295, issued to the City for control of effluent from the Village Creek WWTF, expired on 1 May 1977 and has since been administratively extended until a new permit is issued. TDWR Permit Number 10494 expired on 26 November 1979, and likewise has been extended. Effluent limitations established by each permit are listed in Table 4-10. Both permits contain conditions which state that if the permit expires and is not renewed, then the requirements of the permit remain in effect. The City's draft facilities plan states that the Village Creek WWTF is now operating under the expired NPDES permit. However, discussions with the TDWR indicate that as far as the state is concerned, the Village Creek WWTF is operating under the TDWR's more stringent advanced secondary limitations, currently defined as 10/15 (BOD/TSS) (Tomme 1983).

Designated water uses for Segment 0805 now include only irrigation and industrial supply. Other previously designated uses, including contact recreation, propagation of fish and wildlife, and domestic raw water supply were deleted by water quality standards revisions issued by TDWR in 1981 (White 1983).

TABLE 4-9. RAW WASTEWATER POLLUTANT CHARACTERISTICS USED BY THE CITY AS A BASIS FOR DEVELOPMENT OF FACILITIES PLAN ALTERNATIVES

Parameters	Units	ADF	NDF	MDF	2HP
Flows					
Year 1985 Flows	mgd	96	115	240	326
Year 2005 Flows	mgd	137	165	341	464
BOD	mg/l	275	275	185	140
TSS	mg/l	295	295	240	175
Ammonia-Nitrogen	mg/l	31.7	-	-	-
Total Solids	mg/l	984	-	-	-
Total Settleable Solids	ml/l	8.9	-	-	-
COD	mg/l	610	-	-	-
Total Phosphate (P)	mg/l	6.94	-	-	-
Ortho Phosphate as P	mg/l	5.83	-	-	-
pH	-	6.8	-	-	-
Metal Series					
Aluminum (Al)	mg/l	6.40	-	-	-
Cadmium (Cd)	mg/l	0.04	-	-	-
Chromium (Cr)	mg/l	0.09	-	-	-
Copper (Cu)	mg/l	0.08	-	-	-
Iron (Fe)	mg/l	1.34	-	-	-
Manganese (Mn)	mg/l	0.10	-	-	-
Nickel (Ni)	mg/l	0.07	-	-	-
Lead (Pb)	mg/l	0.08	-	-	-
Zinc (Zn)	mg/l	0.30	-	-	-

ADF: Average Daily Flow
NDF: Normal Daily Flow
MDF: Maximaum Daily Flow
2HP: 2-Hour Peak Flow

SOURCE: CDM et al. 1981b.

TABLE 4-10. EXISTING PERMIT LIMITATIONS APPLICABLE TO THE FORT WORTH VILLAGE CREEK WWTF

Permit	Parameter	Effluent Limit (30-day Average)
• EPA NPDES Permit TX 0047295 (Expired 1 May 1977)	BOD	20 mg/l
	TSS	45 mg/l
	Chlorine Residual	1 mg/l
	Fecal Coliform	200/100 ml
• TDWR WCO Permit WCO 10494 (Expired 26 November 1979)	BOD	10 mg/l
	TSS	10 mg/l
	Chlorine Residual	1 mg/l
	Fecal Coliform	200/100 ml
	pH	6.0 - 9.0
	Dissolved Oxygen	4.0, but not to exceed natural dissolved oxygen in the Trinity River

SOURCE: ADAPTED FROM CDM et al. 1983.

Two intensive water quality surveys have been conducted by TDWR during moderate to low flow conditions on the West Fork Trinity River. The first survey was conducted in September 1982 when the river was at low flow upstream from the Elm Fork confluence and at moderate flow conditions downstream. The second survey, was conducted in October 1982 and the flow conditions of the first study were reversed. Both surveys included sampling on the West fork at 27 mainstream stations, four tributaries, and seven municipal sewage treatment plants. Diurnal field measurements, composite water samples and extensive hydrological data (flows, cross sections, and time-of-travel) were collected on both studies. A gaseous tracer method was used to determine stream reaeration rates on the second survey. In addition to these two sets of data the USGS collected five sets of hydraulic data from the West Fork Trinity River during the period 1972-1980. One of their studies also included determinations of stream regeration rates.

TDWR has begun collating the data from the above mentioned sources but the work is in the very early stages of preparation. Enough data exists to calibrate a computer water quality model for Segment 0805, but an additional set of low flow data throughout the entire length of the segment will be needed for model verification. TDWR intends to collect the additional water quality and hydraulic data in the summer of 1983. The model is scheduled to be calibrated by May 1983 and verified by December 1983. TDWR also feels that a variable flow analysis to evaluate seasonal permits for Segment 0805 may be completed by June 1984 (White 1983).

To meet 10/15 (BOD/TSS) limits, advanced treatment units would be required. EPA's Municipal Wastewater Treatment Construction Grant Amendments of 1981 state that projects proposing advanced wastewater treatment (AWT) would be funded only if EPA, in conducting an AWT review, determines that providing AWT would improve the water quality and/or designated uses of the receiving stream. If there is no documentation that water quality improvements would result from implementing AWT, then EPA potentially could refuse to provide grant assistance for the proposed project.

The NCTCOG has utilized a continuous automated monitoring (CAM,) system since 1977 to monitor water quality of the West Fork of the Trinity River. The CAM system measures dissolved oxygen (DO) levels in the Trinity River as a key indicator of water quality. Aquatic life thrives when DO is 5.0 or greater, but is threatened when DO falls below 2.0. One monitor (CAM 1) is located upstream of the Village Creek WWTF, while a second monitor (CAM 2) is located below the WWTF. Thus the difference in water quality as measured at CAM 1 and CAM 2 can be interpreted as an indication of the effect of the Village Creek WWTF on water quality of the Trinity River.

A summary of CAM data from May 1977 through April 1982 is listed in Table 4-11. The table lists the average yearly DO at CAM 1 and CAM 2 and the corresponding average yearly BOD of the effluent discharged from the Village Creek WWTF for a 5-year period. The data presented for BOD during the first two years is an equivalent BOD which represents the actual wasteload discharged by both the Village Creek WWTF and the Riverside WWTF which was abandonded in 1979. A review of Table 4-11 indicates that an improvement in DO levels in the Trinity River occurred from the period May 1980 to April 1981 to the period May 1981 to April 1982. However, this improvement potentially is a result of the increased flow in the Trinity River rather than the improved effluent discharged from the Village Creek WWTF.

4.3.5 TRA Transfer Pipeline

Once population projections, flow and wasteload characteristics, and effluent limitations were established, the next step was to develop alternatives for collection and treatment of wastewater in the facilities planning area for the period 1985-2005. It quickly became evident that neither new or expanded treatment facilities could be designed and constructed by 1985. However, the existing plant according to projections would not be able to treat flows adequately after 1985. Since the planning period is 1985-2005, provisions for adequately treating all flows generated during this period must be included in the facilities plan. An alternative to building new treatment facilities was needed as a stop-gap measure.

Presently, TRA's Central WWTF treatment capacity is committed to its customer cities, however, negotiations between the City and TRA indicated that for a 6-year period (1984-1990) 15 mgd of sewage potentially could be diverted from

TABLE 4-11. SUMMARY OF TRINITY RIVER WATER QUALITY AND VILLAGE CREEK WWTF EFFLUENT QUALITY FOR A 5-YEAR PERIOD

	May 1977 to April 1978	May 1978 to April 1979	May 1979 to April 1980	May 1980 to April 1981	May 1981 to April 1982
CAM 1					
Annual mean DO (mg/l)	8.6	8.8	8.9	8.2	8.8
Annual mean Flow (cfs)	79.0	131.0	332.0	91.0	*
Village Creek WWTF					
Effluent BOD (mg/l)	44.0[a]	28.0[a]	41.0	58.0	18.0
CAM 2					
Annual mean DO (mg/l)	2.6	3.8	3.9	2.4	6.0
Annual mean flow (cfs)	210.0	334.0	549.0	278.0	1,272.0

[a] Indicates an equivalent value for both the Village Creek WWTF and Riverside WWTF.

* Data unavailable from USGS.

SOURCE: ADAPTED FROM NCTCOG 1982.

the Village Creek WWTF to TRA's Central WWTF, which is located approximately 10 miles east of the Village Creek WWTF on the Trinity River. This diversion would occur only after the TRA's Central WWTF customer cities have granted approval. The diversion would occur by constructing a new gravity flow pipeline from the Village Creek WWTF to a sewage collection main currently serving the TRA facility. It is believed that both the sewage collection main and the TRA plant have the capacity to handle the additional 15 mgd sewage flow without damaging the collection main or affecting the excellent quality effluent produced by the TRA plant. It is anticipated that the 15 mgd flow transfer would cease in 1990, at which time the City should have built whatever facilities necessary to satisfactorily collect and treat all flows generated in the facilities planning area. However, it may be appropriate to extend the transfer agreement beyond 1990, if necessary and agreed to by both parties. Details concerning the possible transfer line (e.g., pipe diameter, material, design alignment, and pipe slope) currently are not available. Although negotiations are still occurring and details of the anticipated joint contract are not firm, this proposed TRA transfer line is included in all alternatives as part of the facilities plan. The City of Fort Worth would request from TDWR a determination of eligiblity for grant funding for construction of the TRA transfer line.

4.3.6 Economic Factors

Economic factors must be developed in accordance with construction grant regulations and applied evenly to the evaluation of all alternatives. If several alternatives are developed using a different basis for costs, different discount rates, and different planning (cost amortization) periods, then cost comparisons between alternatives would be futile. Table 4-12 lists economic factors utilized throughout the development and evaluation of alternatives as described in this EIS.

4.4 IDENTIFICATION OF ALTERNATIVE COMPONENTS

Once standard planning and design information applicable to all alternatives was developed (as described in Section 4.3), various components of complete sewerage systems were identified and evaluated. Components identified as

TABLE 4-12. ECONOMIC FACTORS UTILIZED FOR DEVELOPMENT AND EVALUATION OF COST INFORMATION ASSOCIATED WITH FACILITIES PLAN ALTERNATIVES

A. All salvage values and replacement costs are based on a 20-year planning period.

B. EPA discount rate = 7 3/8% (7.375)

C. Land costs are assumed to inflate at a rate of 3% per year.

D. Costs based on Engineering News Record (ENR) Index = 3334 (approximately September 1980 dollars).

E. Capital cost equals 15% construction contingency, 10% design and investigation, 4% construction investigation, and 2% start-up services. The multiplier to convert construction cost to capital cost is 1.31.

F. Design Life of facilities:

Auxiliary Equipment	10 years
Motorized Vehicles	6.67 years
Major Process Equipment	20 years
Plant Pipelines & Structures	40 years
Other Pipelines	40 years

Where significant, depreciation is assumed to be straight line.

G. Current electricity cost = $0.04/kwh (Sept. 1980)

H. Annual O&M Cost escalation rate = 10% (to account for annual increase in maintenance, plus allowance for moderate replacement of major equipment parts. Inflation is not included).

SOURCE: CDM et al. 1983.

being applicable to alternatives for the Fort Worth facilities plan included: wastewater collection system, treatment plant sites, wastewater treatment technology, effluent discharge, and sludge treatment and disposal.

4.4.1 Wastewater Collection System

There are various options available for collecting and conveying sewage, including: gravity sewers, force mains, and vacuum and pressure sewers serving individual and/or cluster treatment systems. As described earlier, virtually all of Fort Worth's existing collection system is composed of gravity sewers. Fort Worth's existing collection mains are graphically illustrated in Figure 4-1. It was determined that no individual system or small group cluster system would be served by public facilities, thus pressure and vacuum sewers were eliminated from consideration. Due to cost savings, it was determined that gravity sewers would be utilized wherever possible.

The I/I analysis conducted by Fort Worth as part of this facilities plan identified several existing major collection mains that would not be able to convey all of the sewage projected to be generated within the watersheds served. Existing and required collection main capacities, and resulting mains needing improvements now and/or by design year 2005 are listed in Table 4-13. Collection mains needing improvement during the planning period are graphically illustrated in Figure 4-4. Two of these collection mains (Rush Creek and Big Fossil Creek) currently are being designed or constructed totally at City expense or as part of other construction grant programs, and thus do not constitute part of the Fort Worth facilities plan. The remaining collection mains which are proposed as part of the City's facilities plan and their corresponding construction costs are listed in Table 4-14.

The proposed collection mains have been preliminarily designed with an alignment closely paralleling existing collection mains. These proposed alignments were evaluated and found to be environmentally sound. This is because a minimum amount of new land (right-of-way) would be required since existing easements associated with the present collection system would be used to the greatest extent possible. By staying in existing easements where land disturbing pipe-laying activities already have occurred, new lands containing

TABLE 4-13. EXISTING AND REQUIRED CAPACITIES AND NEEDED IMPROVEMENTS TO THE FORT WORTH SEWAGE COLLECTION SYSTEM

Interceptor Sewer	Existing Capacity (MGD)	Existing Flow (MGD)	Capacity Required Beyond Present (1980) Capacity (MGD)	Projected Flow (2005) (MGD)	Capacity Required(2005) Beyond Present Capacity (MGD)
Rush Creek	0[a]	16	16	27	27
	0[b]	55	55	84	84
Village Creek	40.5	51.8	11.3	77	36.5
Sycamore Creek	48.0	39.1	0	44.6	0
Clear Fork	31.0	48.7	17.7	68.3	37.3
Benbrook Collector	19.6	4.6	0	11.3	0
Marine Creek	39.8	15.5	0	27.7	0
Little Fossil Creek	18.0	10.4	0	13.5	0
West Fork	25.9	25.7	0	34.6	8.7
Big Fossil	0[c]	17.6	17.6	37.2	37.2
Walker Branch	21	23.9	2.9	32.5	11.5
72"-M-245	77.5	113	35.5	148	70.5
96"-M280	257	210	0	262	5

[a] Upper Rush Creek Only

[b] At maximum flow section - assumes replacement of existing line.

[c] Assumes replacement of existing force main.

[d] Assumes ultimate collection at V.C. W.W.T.P.

[e] West Fork Interceptor needs additional capacity in some upstream sections both in 1980 and in 2005.

SOURCE: CDM et al. 1981b.

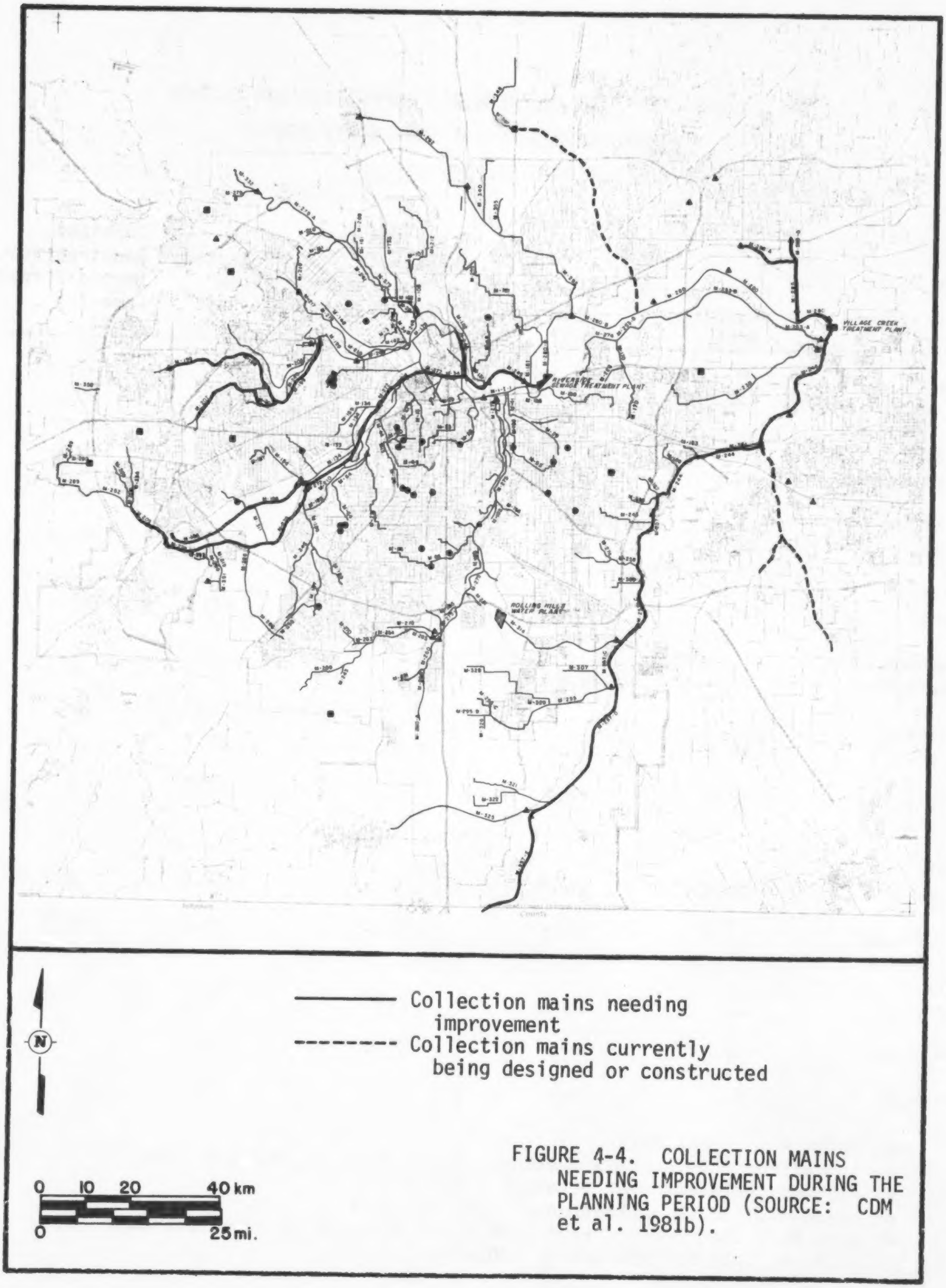
VILLAGE CREEK TREATMENT PLANT
RIVERSIDE SEWAGE TREATMENT PLANT
ROLLING HILLS WATER PLANT
Collection mains needing improvement
Collection mains currently being designed or constructed
N
0 10 20 40 km
0 25 mi.

FIGURE 4-4. COLLECTION MAINS NEEDING IMPROVEMENT DURING THE PLANNING PERIOD (SOURCE: CDM et al. 1981b).

TABLE 4-14. SEWAGE COLLECTION MAINS PROPOSED AS PART OF THE FORT WORTH FACILITIES PLAN

Collector Mains	Estimated Construction Cost (Dollars)	Estimated Capital Cost (Dollars)[a]
Village Creek	$14,400,000	$19,300,000
Clear Fork	7,460,000	10,000,000
West Fork	2,650,000	3,550,000
Walker Branch	957,000	1,280,000
72" (M-245)	4,220,000	5,650,000
96" (M-280)	370,000	500,000
Connection to TRA System	$ 2,700,000	$ 3,620,000
TOTAL	$32,757,000	$43,900,000

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a. Capital Cost equals 15% construction contingency, 10% design and investigation, 4% construction investigation, and 2% start-up services.

SOURCE: ADAPTED FROM CDM et al. 1983.

potentially sensitive biological and cultural resources would be avoided. Also, associated cost of converting privately owned land to public use land is avoided. Construction costs would be minimized because additional easements often would not be required, and operation and maintenance costs would be minimized because sewer personnel would be able to inspect and repair multiple collection lines while conducting periodic inspections along common easements. Because of the feasibility and practicality of using proposed alignments adjacent to existing collection mains, alternate collection line alignments were not developed or evaluated.

4.4.2 Treatment Plant Sites

Several treatment plant sites were selected for incorporation into project alternatives. Three large land areas (20,000 to 60,000 acres) were selected as potential sites for land treatment of wastewater and/or land spreading of sludge. These sites were: (1) the Saginaw site north of the city of Saginaw in the north part of the facilities planning area; (2) the Mustang Creek Site in the southwest part of the planning area; and (3) the Mountain Creek site in the southeast part of the planning area. Criteria used for site selection included land use, water rights, land availability, soil characteristics, potential groundwater problems, size of site(s) and physical characteristics (flooding potential and slope). The above criteria mentioned are summarized in three basic requirements: (1) sufficient, relatively contiguous, sparsely populated land, (2) soils suitable for the treatment process contemplated, and (3) located within a reasonable distance from the wastewater source. Also, the Soil Conservation Service was consulted for assistance in determining areas with soils suitable for land treatment of wastewater (CDM 1983b).

In addition, six small (2 to 10 acres) sites were selected as potential sites for satellite treatment plants. These sites were: (1) Clear Fork; (2) Rush Creek; (3) Silver Creek; (4) Big Fossil; (5) Upper Village Creek; and (6) Riverside. A Riverside satellite plant would occupy the same site as the City's old Riverside WWTF which was closed in January 1979. These sites all were located along existing major sewage collection lines, so that additional collection lines would not be required to convey sewage to the satellite plants. Each of these sites is identified in Figure 4-5.

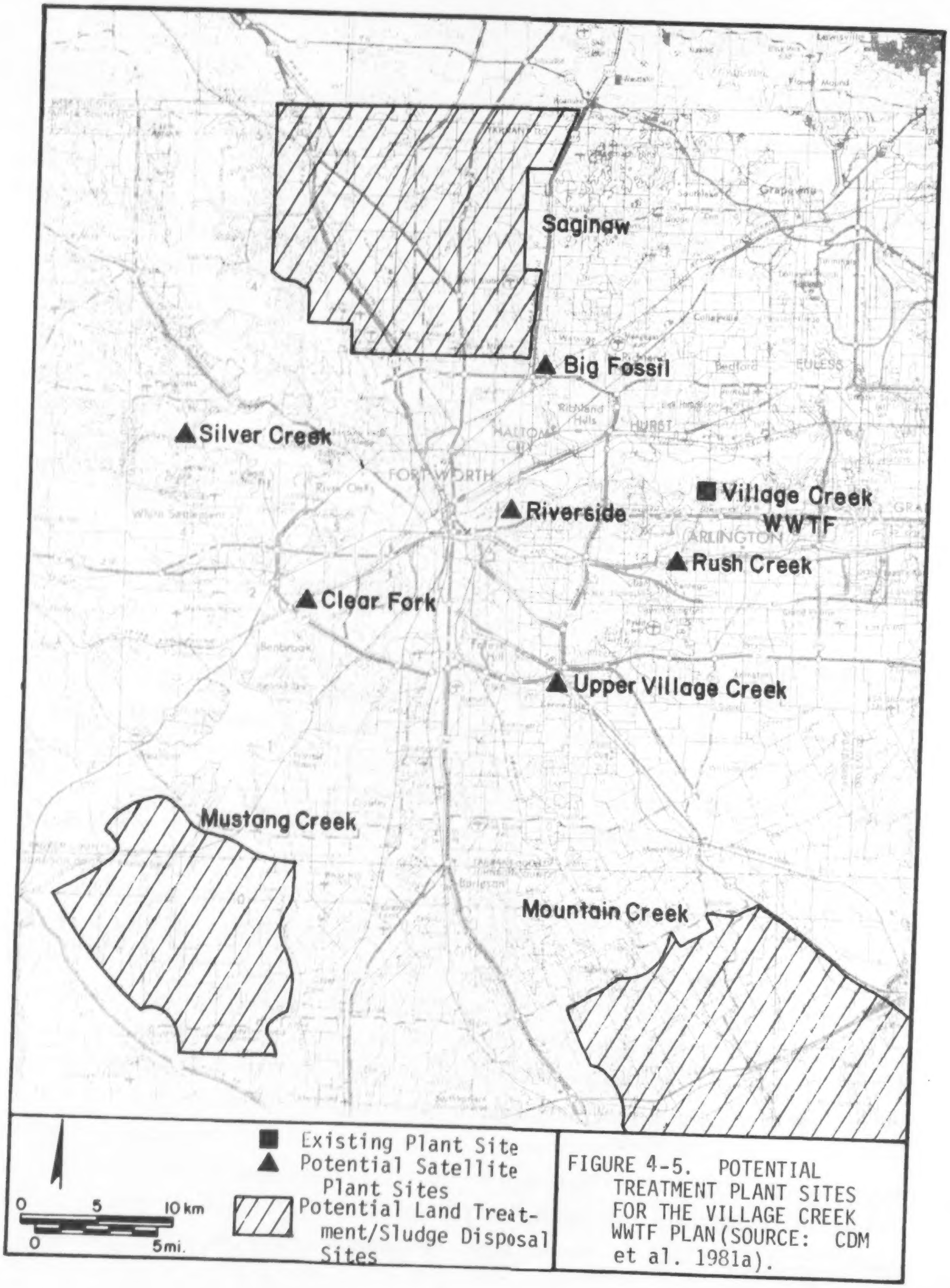

FIGURE 4-5. POTENTIAL TREATMENT PLANT SITES FOR THE VILLAGE CREEK WWTF PLAN (SOURCE: CDM et al. 1981a).

4.4.3 Wastewater Treatment Technologies

The facilities plan considered a variety of treatment technologies. In general, wastewater treatment options include conventional physical, biological, and chemical processes and land treatment. Conventional options utilize preliminary treatment, primary treatment, secondary treatment, and advanced treatment. These unit processes are followed by disinfection prior to effluent disposal. Land treatment processes which achieve advanced treatment levels include slow-rate infiltration or irrigation, overland flow, and rapid infiltration.

The degree of treatment required is dependent on the effluent disposal option selected (Section 4.4.4). Where disposal of treated wastewater is by effluent discharge to surface waters, effluent quality limitations (Section 4.3.2) establish the required level of treatment.

4.4.3.1 Preliminary Treatment and Primary Sedimentation

All conventional sewage treatment options considered in this document incorporate preliminary treatment and primary sedimentation. These unit processes serve to remove coarse solids, readily-settleable suspended solids (TSS), floating solids, and grease from influent wastewater. Preliminary treatment generally consists of a bar screen (a screening device) or a combination of a coarse bar screen and a comminutor, followed by a grit chamber. Solids are ground in the comminutor and left in the waste, thereby eliminating the separate disposal of screenings. A grit chamber is used for removal of inorganic solids such as sand. The existing Village Creek WWTF does not have grit removal at the head (beginning) of the plant, but instead removes grit from primary settled sludge. According to the City's engineers, this has caused numerous equipment maintenance problems, and is directly related to the generation of odors by an inadequate solids handling system (CDM et al. 1981b, 1982). Grit removal is discussed more thoroughly in Sections 4.6 and 4.7 of this EIS. The next treatment unit is a primary sedimentation tank, in which heavy solids settle and light solids float. Sludge (settled solids) and scum (floating solids) are removed to solids (sludge) handling facilities. Clarified liquid flows out of the primary sedimentation tank to subsequent treatment units. Typically, these processes will remove approximately 30 percent of the BOD_5 and about 50 percent of the TSS from wastewater (USEPA 1980a).

4.4.3.2 Secondary Treatment

Secondary treatment typically consists of biological processes in which soluble and colloidal-sized organic substances are removed from wastewater. The most frequently used processes provide a fluid media such as the oxidation ditch and the activated sludge process, or a fixed media such as the trickling filter, rotating biological contactor (RBC), or activated biological filter (ABF) process. Five processes were selected for analysis in the facilities plan: the activated sludge system, the RBC system, the ABF system, the trickling filter, and the oxidation ditch. These systems are described in detail in the facilities plan (CDM et al. 1983). For comparative purposes, a brief discussion of these processes is presented here.

Activated sludge consists of an aerated suspension of microorganisms that utilize organic wastewater for respiration and reproduction. Aeration generally is provided by diffusion of air from the bottom of the tank or mechanical agitation of the surface. Separate settling facilities are used to remove viable organisms from the treated wastewater. There are a number of modifications to the basic activated sludge process, each specific to a different strength of waste. Efficiencies of BOD removal by primary treatment and conventional diffused air and pure oxygen options typically range from 85 to 95 percent (USEPA 1980a).

An oxidation ditch system typically consists of an oval tank that employs the extended aeration activated sludge (aerated suspension) process followed by separate settling facilities. Typical BOD removal ranges from 85 to 95 percent.

Because of long detention times, oxidation ditches normally are not economical or cost-effective for treating flows greater than 10 mgd. Thus, in the facilities plan, consideration of oxidation ditches was limited to satellite plant alternatives of 10 mgd or less.

One of the most common fixed-media treatment systems is the trickling filter. A trickling filter consists of a tank filled with large rock or plastic media with a drain system on the bottom. As sewage passes through the media, biological organisms as they grow and reproduce degrade organic material in the wastewater. Treated wastewater along with excess biomass (waste organisms) is drained to separate settling facilities. Efficiencies of BOD removal by trickling filters typically range from 70 to 85 percent (USEPA 1980a).

RBC and ABF systems are recent advances in fixed-media-type treatment systems. These systems are more compact than conventional rock trickling filter systems. RBCs consist of a fixed medium (disks) on which biological growth develops. The disks rotate partially submerged in wastewater. Separate settling facilities are used to remove slough (excess biomass) from treated wastewater. ABFs consist of a bio-cell with open, fixed growth media, followed by short-term aeration and clarification. Efficiencies of both the RBC and ABF processes are comparable to that of activated sludge (i.e., 85 to 95 percent).

Based on typical primary removal rates of 35 percent and trickling filter efficiencies of 75 percent, a trickling filter plant would be expected to produce a 45/50 (BOD/TSS) effluent. Other activated sludge and fixed-media systems discussed above, which achieve 35 percent primary and 90 percent secondary removal efficiencies, would be expected to produce a 20/20 effluent. Since none of these secondary systems can consistently achieve an effluent better than 20/20, some form of advanced treatment would be required for the Fort Worth system prior to wastewater discharge to the Trinity River.

4.4.3.3 Advanced Treatment

Advanced treatment involves "polishing" (i.e., the additional treatment of) treated wastewater beyond primary and secondary processes. Advanced treatment processes may include physical filtration, chemical treatment, and biological nitrification/denitrification.

Often, advanced treatment is needed to reduce excess levels of nitrogen, phoshorus, and other nutrients in wastewater that can cause undesirable biological growths (algal blooms) and/or significant depletions in levels of dissolved oxygen in rivers and lakes. Most biological nitrification/denitrification systems and chemical treatment systems are designed to remove these excessive amounts of nutrients. Filtration systems are used primarily for reduction of BOD and TSS, although some reduction in nutrients does occur. Based on discharging an average daily flow at the anticipated permit levels and a theoretical carbon/nitrogen/and phosphorus removal ratio of 100 parts BOD_5/ 5 parts nitrogen/and 1 part phosphorus, the effluent nitrogen and phosphorus levels are expected to be 20-25 mg/l and 4-6 mg/l respectively. If additional removal of nitrogen and phosphorous were required additional treatment units would have to be added and/or chemical addition practiced. Based on costs of similar projects costs for extensive nutrient removal treatment, the customer costs could be expected to increase on the order of 200 to 300 percent. In addition to the nutrient removal units or process, additional sludge handling and disposal facilities would be needed, since additional solids would be generated (CDM 1983b). An "added-on" nutrient removal system would certainly cost more to construct than a similar "designed-in" system. The magnitude of the difference in cost would depend on the process selected and the method of implementation.

The recommended design for treatment to advanced secondary levels is adaptable to a variety of nutrient removal process, including physical-chemical, suspended growth biological, attached growth biological and patented processes (CDM 1983b). However, the City of Fort Worth does not anticipate nutrient limitations being required for the Village Creek WWTF. Thus, dual-media filtration was the only conventional advanced treatment system evaluated. Since the existing Village Creek WWTF already uses dual-media filtration, expansion of the existing units was determined to be potentially more cost-effective than utilization of other available advanced treatment units. Dual-media filtration typically involves use of a gravity flow filter containing two types of filtration media (usually sand, gravel, anthracite, or garnet). Removal of BOD and TSS is conducted by the virtual filtering or screening of wastewater as it passes through the two filtration media.

Dual-media filtration units periodically are backwashed to remove trapped pollutants from the filters.

4.4.3.4 Land Treatment

Land treatment is a treatment technology that often replaces conventional secondary and advanced treatment technologies. Land treatment of wastewater utilizes natural physical, chemical, and biological processes in vegetation, soils, and underlying formations to renovate and dispose of domestic wastewater. Land application methods have been practiced in the United States for over 100 years and presently are being used by hundreds of communities throughout the Nation (Pound and Crites 1973). In addition to wastewater renovation, advantages of land treatment may include groundwater recharge, soil conditioning, and augmented plant growth. Applicability of this treatment option depends significantly on social acceptance, costs, and the amount of energy required to transport sewage to the treatment site.

The three principal processes utilized in land treatment of wastewater include: (1) overland flow; (2) slow rate irrigation; and (3) rapid infiltration.

In the overland flow process, primary or secondary treated wastewater is allowed to flow over a sloping surface and is collected at the bottom of the slope. This type of land application system usually is followed by discharge of effluent to a receiving stream. Overland flow generally results in BOD and TSS removal efficiencies of 90 to 95 percent. Phosphorus removal usually ranges from 30 to 60 percent. Only moderate land acreages are required for overland flow systems, because application rates of wastewater range from 4 inches per week (in/wk) to over 10 in/wk (USEPA 1980a). A well-designed and properly operated overland flow system potentially would achieve the anticipated 10/15 effluent limitations.

In the slow rate irrigation method, primary or secondary treated wastewater is applied to land to enhance growth of crops or grasses. Wastewater is applied by spray, ridge and furrow, or flood methods, depending on soil drainage characteristics and type of vegetation. Application rates range from 0.5 to

4.0 inches per week. Final renovation of wastewater occurs in the first 2 to 4 feet of soil, as organic matter, phosphorus, heavy metals, and bacteria are retained by adsorption and other mechanisms. Nitrogen is taken up by plants as they grow, and removals may be as high as 90 percent. Water is lost from the system through infiltration and evapotranspiration. Probability of affecting groundwater quality is moderate, and a minimum depth to groundwater of 5 feet is recommended (USEPA 1977). Large amounts of land are needed for the slow rate process.

The rapid infiltration method involves high rates of application (4 to 120 in/wk) to rapidly permeable soils such as sands and loamy sands. Although vegetative cover may be present, it is not an integral part of the system. Cleansing of wastewater occurs within the first few feet of soil by filtering, adsorption, chemical precipitation, and other geochemical reactions. In most cases, TSS, BOD, and fecal coliform organisims are removed almost completely. Phosphorus removal can range from 70 to 90 percent, depending on physical and chemical properties of soils. Nitrogen removal generally is less significant, unless specific procedures are established to maximize denitrification (USEPA 1977).

In rapid infiltration systems, there is little or no consumptive use of wastewater by plants, and only minor evaporation occurs. Because most of the wastewater infiltrates into the soil, groundwater quality may be affected. To minimize the potential for groundwater contamination at a rapid infiltration site, minimum depth to the water table should be 10 feet. Due to extremely rapid rates of infiltration, permeability of the underlying aquifer must be high to insure that the water table does not mound significantly and limit operations on site.

4.4.3.5 Disinfection

Disinfection processes are used in conjunction with both conventional and land treatment systems to remove disease-causing organisms. One alternative is chlorination, which can reliably meet present bacteriological standards. Residual chlorine, however, can reach toxic levels if chorine is not applied properly or if the retention time is not sufficient. The other alternative is ozonation, which does not leave residual reaction products but is significantly more costly than chlorination. Therefore, chlorination was selected as the disinfection process to be included in all alternatives. It was assumed that chlorine would be carefully applied and that residual levels would be monitored regularly.

Tàble 4-15 identifies wastewater treatment technologies typically evaluated for proposed wastewater treatment facilities, and indicates those technologies identified for evaluation in the Fort Worth facilities plan.

4.4.4 Effluent Disposal

Treated effluent can be disposed of in four ways: (1) discharge to receiving waters (i.e., streams or lakes); (2) disposal on land; (3) direct reuse by industrial facilities as makeup water; and (4) underground injection. Discharge and land disposal systems also can involve beneficial reuse of wastewater, such as using wastewaters discharged into a reservoir to supplement drinking water supplies and/or disposal on land via beneficial irrigation of parks, golf courses, highway medians, or agricultural lands. Underground injection of treated wastewater is not commonly used, and thus was dropped from further consideration. Discharge to receiving waters, land disposal, and industrial reuse were retained as potential options for effluent disposal.

4.4.5 Sludge Treatment and Disposal

Sludge consists of organic and inorganic solids which are settled out or otherwise removed from liquid waste streams during wastewater treatment. Sludge is treated and disposed of typically by three major processes: (1) stabilization; (2) dewatering; and (3) disposal. Additional process steps such as thickening, conditioning, drying, disinfection, and reduction are available to enhance the success of the three major processes previously mentioned.

Sludge removed from primary and secondary clarifiers typically is at 1.0 to 2.5 percent solids content. To make subsequent processes more economical, sludge generally is thickened using gravity or mechanical thickening systems

TABLE 4-15. WASTEWATER TECHNOLOGIES TYPICALLY EVALUATED AND IDENTIFICATION OF TECHNOLOGIES EVALUATED FOR THE FORT WORTH FACILITIES PLAN

Technology Component	Component Options
Preliminary and Primary Treatment	* Screening
	Comminution
	Gravity Grit Chamber
	Aerated Grit Chamber
	Cyclone Separators
	Dissolved Air Flotation
	* Primary Sedimentation
	Chemical Addition
Secondary Treatment	* Trickling Filter
	* Activated Sludge (Conventional)
	Activated Sludge (Pure Oxygen)
	Contact Stabilization
	Extended Aeration
	* Biological Activated Filter
	* Oxidation Ditch
	Physical/Chemical
	* Rotating Biological Contactors
	Aerated Lagoons
Advanced Treatment	* Dual Media Filtration
	Activated Carbon Adsorption
	Two-Stage Lime Treatment
	Breakpoint Chlorination
	Biological Nitriciation/ Denitrification
	Ammonia Stripping
	Microscreening
	Phostrip
Land Treatment (Secondary/Advanced)	* Slow Rate Irrigation
	* Overland Flow
	* Rapid Infiltration
Disinfection	* Chlorination
	Dechlorination
	Ozonation

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* Indicates treatment options evaluated for the Fort Worth draft facilities plan.

to 4.0 or 5.0 percent solids. Dissolved air flotation and centrifuge thickening processes were selected by the City for evaluation in the facilities plan. Sludge then is stabilized, a process which basically converts organic matter (via biological or chemical means) into a stable, unoffensive form. Anaerobic digestion, the stabilization process utilized at the existing Village Creek WWTF, was chosen by the City for evaluation in the facilities plan.

Prior to dewatering, sludge often is conditioned. Conditioning sludge by chemical or thermal processes changes physical and chemical properties of the sludge to make subsequent dewatering steps more effective. Both chemical conditioning (lime and organic polymer addition) and thermal conditioning processes were selected by the City for evaluation. Once sludge is conditioned, it then is dewatered.

Sludge with 3.0 to 5.0 percent solids can be dewatered to 20 to 25 percent solids by air drying methods, and can be dewatered to 25 to 50 percent solids by various mechanical methods. Air drying methods basically include sand drying beds and lagoons. Because lagoon systems typically are unreliable and have high potential for creating odor and health problems, sand drying beds were selected by the City for evaluation. In addition, centrifuge, belt press, and filter press mechanical dewatering systems were selected by the City for evaluation.

Supplemental sludge drying to produce a cake with 65 percent solids or more is utilized only on special occasions to meet requirements of specific subsequent disinfection or disposal equipment. Supplemental drying was determined to be unnecessary for subsequent units evaluated for the Fort Worth facilities plan.

Disinfection of sludge is required by EPA regulations if sludge is going to be used as a soil conditioner for food-chain crops (40 CFR 257). Additional discussions of EPA's sludge disposal regulations are contained in Sections 4.7 and 5.12 of this document. One disinfection method, composting, was selected by the City for evaluation for this project.

Sludge volume reduction processes occasionally are utilized to lower the cost of sludge transportation and disposal by reducing the volume of sludge which must be handled. However, volume reduction processes often are extremely costly. One reduction process, incineration, was selected by the City for evaluation in the facilities plan. Sludge or ash cannot feasibly be disposed of in the air, and water disposal (e.g., discharge to streams or ocean dumping) generally is prohibited. Therefore, ultimate disposal of sludge likely would involve placing sludge on or in the ground. Three land disposal methods, landspreading, dedicated land disposal, and landfilling were selected by the City for evaluation in the Fort Worth facilities plan. Major sludge process components and options typically evaluated during facilities planning and processes selected for evaluation in the Fort Worth facilities plan are identified in Table 4-16.

4.5 DEVELOPMENT AND SCREENING OF PRELIMINARY ALTERNATIVES

4.5.1 Development of Preliminary Alternatives

After alternative components were identified (as described in Section 4.4 of this EIS), preliminary alternatives for collection and treatment of wastewater in the Fort Worth service area were identified. Preliminiary alternatives were identified or designated by selecting various options for each of the five major components described in Section 4.4.3; i.e.: (1) type and location of collection system; (2) treatment plant site(s); (3) wastewater treatment technology to be used; (4) effluent disposal; and (5) sludge treatment and disposal. From the component options selected, over 300 preliminary alternatives were identified for collection and treatment of 137 mgd of wastewater in design year 2005. To properly discuss and evaluate these 300 preliminary alternatives, the alternatives were grouped in 19 major alternative groups, as identified in Table 4-17. Detailed descriptions of the treatment processes considered, costs of liquid treatment and solids handling options, land requirements, energy consumption, personnel requirements, system reliability, and other factors pertaining to the preliminary alternatives are contained in the report entitled "Broad Scale Alternatives for Initial Screening for the Fort Worth 201 Facilities Plan" prepared for the City by CDM (CDM et al. 1981a).

TABLE 4-16. MAJOR SLUDGE TREATMENT AND DISPOSAL COMPONENTS AND OPTIONS TYPICALLY EVALUATED FOR APPLICABILITY AND IDENTIFICATION OF TECHNOLOGIES EVALUATED FOR THE FORT WORTH FACILITIES PLAN

Components	Options
Sludge Thickening	Gravity * Dissolved Air Flotation * Centrifuge Vaccum Filtration
Stabilization	* Anaerobic Digestion Aerobic Digestion Lime Treatment Heat Treatment
Conditioning	* Lime Ferric Chloride * Organic Polymers Elutriation * Thermal
Dewatering	* Drying Beds Lagoons * Centrifuge Vacuum Filters * Belt Press * Filter Press
Supplemental Drying	Flash Dryer Multiple Hearth Rotary Kiln Atomized Spray Tower Solar-Assisted Beds/Kilns
Disinfection	Pasteurization * Composting Electron Beam Irradiation Cesium-137 Irradiation Cobalt-60 Irradiation
Reduction	* Incineration Wet Oxidation
Final Sludge or Ash Disposal	* Landspreading Lagooning * Dedicated Land Disposal * Landfilling

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* Indicates treatment options evaluated for the Fort Worth draft facilities plan.

TABLE 4-17. PRELIMINARY ALTERNATIVES (BY GROUP) IDENTIFIED FOR EVALUATION IN THE FORT WORTH FACILITIES PLAN

Group Number	Collection System	Treatment Plant Site	Treatment Technology Flow	Effluent Discharge
1A (No Action)	Maintain Existing Collection Mains to Village Creek WWTF	Village Creek WWTF	Maintain Existing Secondary Biological System (96 mgd)	Discharge to Receiving Streams
1 (Limited Action)	Build New Collection Mains to Convey 137 mgd to Village Creek WWTF	Village Creek WWTF	Maintain Existing Secondary Biological System (96 mgd)	Discharge to Receiving Streams
2 (Expand Village Creek)	Build New Collection Mains to Convey 137 mgd to Village Creek WWTF	Village Creek WWTF	Expand Village Creek With Advanced Biological System (137 mgd)	Discharge to Receiving Stream or Reuse
3 (Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants.	● Village Creek ● Rush Creek ● Clear Fork	● Add advanced Biological treatment (96 mgd) ● Advanced Biological (29 mgd) ● Advanced Biological (12 mgd)	Discharge to Receiving Stream or Reuse

TABLE 4-17. PRELIMINARY ALTERNATIVES (BY GROUP) IDENTIFIED FOR EVALUATION IN THE FORT WORTH FACILITIES PLAN (CONTINUED)

Group Number	Collection System	Treatment Plant Site	Treatment Technology Flow	Effluent Discharge
4 (Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek	● Add advanced Biological treatment (96 mgd)	Discharge to Receiving Stream or Reuse
		● Riverside	● Advanced Biological (30 mgd)	
		● Big Fossil Creek	● Advanced Biological (6 mgd)	
		● Silver Creek	● Advanced Biological (5 mgd)	
5 (Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek WWTF	● Add Advanced Biological Treatment (96 mgd)	Discharge to Receiving Stream or Reuse
		● Riverside	● Advanced Biological (25 mgd)	
		● Upper Village Creek	● Advanced Biological (11 mgd)	
		● Silver Creek	● Advanced Biological (5 mgd)	
6 (Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek WWTF	● Add advanced Biological treatment (96 mgd)	Discharge to Receiving Stream or Reuse
		● Riverside	● Advanced Biological (41 mgd)	

TABLE 4-17. PRELIMINARY ALTERNATIVES (BY GROUP) IDENTIFIED FOR EVALUATION IN THE FORT WORTH FACILITIES PLAN (CONTINUED)

Group Number	Collection System	Treatment Plant Site	Treatment Technology Flow	Effluent Discharge
7 (Interim Transfer)	Build New Collection Mains to Village Creek, and Temporary Transfer Line to TRA Central	● Village Creek WWTF ● TRA Central ● Ultimate Site Selected Later	● Add advanced Biological treatment (96 mgd) ● Existing Plant (41 mgd) ● Advanced Biological Treatment or Land Treatment (137 mgd)	Discharge to Receiving Stream or Reuse
8 (Permanent Transfer)	Build New Collection Mains to Village Creek, and Permanent Transfer Line to TRA Central	● Village Creek WWTF ● TRA Central	● Add advanced Biological Treatment (96 mgd) ● Existing Plant (41 mgd)	Discharge to Receiving Stream or Reuse
9 (Land Treatment in Floodplain)	Build New Collection Mains to Village Creek WWTF, and Force Main to Overland Flow Site in Trinity River Floodplain	● Village Creek WWTF ● Trinity River Floodplain	● Add Advanced Biological Treatment (96 mgd) ● Overland Flow (41 mgd)	Discharge to Receiving Streams or Reuse
10 (Land Treatment within 15 Miles)	Build New Collection Mains to Village Creek WWTF, and Force Main to Land Treatment Site	● Village Creek WWTF ● Land Treatment Site Within 15 Miles of Village Creek WWTF	● Add Advanced Biological treatment (96 mgd) ● Overland Flow (41 mgd)	Discharge to Receiving Stream or Reuse

TABLE 4-17. PRELIMINARY ALTERNATIVES (BY GROUP) IDENTIFIED FOR EVALUATION IN THE FORT WORTH FACILITIES PLAN (CONTINUED)

Group Number	Collection System	Treatment Plant Site	Treatment Technology Flow	Effluent Discharge
11 (Land Treatment Within 30 Miles)	Build New Collection Mains to Village Creek WWTF, and Force Main to Land Treatment Site	● Village Creek WWTF ● Land Treatment Site Within 30 Miles of Village Creek WWTF	● Add Advanced Biological Treatment (96 mgd) ● Overland Flow (41 mgd)	Discharge to Receiving Streams or Reuse
12 (Land Treatment of 137 mgd)	Build New Collection Mains to Village Creek WWTF, and Force Main to Land Treatment Site	● Village Creek WWTF ● Land Treatment Site in Floodplain of Trinity River	● Add Primary Treatment Facilities (137 mgd) ● Overland Flow (137 mgd)	Discharge to Receiving Stream or Reuse
13 (Land Treatment at Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek ● Rush Creek ● Clear Fork	● Add Advanced Biological Treatment (96 mgd) ● Overland Flow (29 mgd) ● Overland Flow (12 mgd)	Discharge to Receiving Streams or Reuse

TABLE 4-17. PRELIMINARY ALTERNATIVES (BY GROUP) IDENTIFIED FOR EVALUATION IN THE FORT WORTH FACILITIES PLAN (CONTINUED)

Group Number	Collection System	Treatment Plant Site	Treatment Technology Flow	Effluent Discharge
14 (Land Treatment at Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek	● Add Advanced Biological Treatment (96 mgd)	Discharge to Receiving Stream or Reuse
		● Riverside	● Overland Flow (30 mgd)	
		● Big Fossil Creek	● Overland Flow (6 mgd)	
		● Silver Creek	● Overland Flow (5 mgd)	
15 (Land Treatment at Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek WWTF	● Add Advanced Biological Treatment (96 mgd)	Discharge to Receiving Streams or Reuse
		● Riverside	● Overland Flow (25 mgd)	
		● Upper Village	● Overland Flow (11 mgd)	
		● Silver Creek	● Overland Flow (5 mgd)	
16 (Land Treatment at Satellite Plants)	Build New Collection Mains to Village Creek WWTF and Satellite Plants	● Village Creek WWTF	● Add Advanced Biological Treatment (96 mgd)	Discharge to Receiving Stream or Reuse
		● Riverside	● Overland Flow (41 mgd)	

TABLE 4-17. PRELIMINARY ALTERNATIVES (BY GROUP) IDENTIFIED FOR EVALUATION IN THE FORT WORTH FACILITIES PLAN (CONCLUDED)

Group Number	Collection System	Treatment Plant Site	Treatment Technology Flow	Effluent Discharge
17 (Land Treatment With 25 Miles)	Build New Collection Mains to Village Creek WWTF, and Force Main to Land Treatment Site	• Village Creek WWTF • Land Treatment Site Within 25 Miles of Village Creek WWTF	• Add Advanced Biological Treatment (96 mgd) • Slow-rate Irrigation (41 mgd)	Discharge to Receiving Streams or Reuse
18 (Land Treatment Within 50 Miles)	Build New Collection Mains to Village Creek WWTF, and Force Main to Land Treatment Site	• Village Creek WWTF • Land Treatment Site Within 50 Miles of Village Creek WWTF	• Add Advanced Biological Treatment (137 mgd) • Slow-rate Irrigation (41 mgd)	Discharge to Receiving Streams or Reuse
19 (Land Treatment in Floodplain)	Build New Collection Mains to Village Creek WWTF, and Force Main to Land Treatment Site	• Village Creek WWTF • Land Treatment Site in Flooplain of Trinity River	• Maintain Existing Secondary Biological System (137 mgd) • Rapid Infiltration (137 mgd)	Discharge to Receiving Streams or Reuse

SOURCE: ADAPTED FROM CDM et al. 1981a.

4.5.2 Screening of Preliminary Alternatives

Evaluation (or "screening") of the preliminary alternatives was accomplished using the following engineering, environmental, and administrative criteria:

- Energy Use
- Number of Operating Personnel Required
- Length of Collection Mains Required
- Capital Cost
- Annual Operation and Maintenance Cost
- Total Present Worth of the System
- Adaptability of Resource Recovery and/or Wastewater Reuse
- Potential For Generation of Undesirable Odors
- Effects on Floodplains and Floodways
- Feasibility of Implementation
- Effects on Water Rights
- Consistency with Areawide Water Quality Management Plan (Section 208)
- Reliability of Facilities
- Restrictions on Population Growth
- Quantity of Sludge Produced Which Must be Treated and Disposed
- Land Requirements
- Generation of Significant Air Emissions
- Effects on Groundwater
- Effects on Public Health
- Generation of Undesirable Noise Levels Near Sensitive Receptors
- Generation of Undesirable Aesthetic Effects
- Compliance with NPDES Limitations or Other Permit Requirements
- Public Acceptability

Results of the screening of preliminary alternatives are depicted in Table 4-18. The table provides numerical data for quantifiable items such as alternative costs and number of additional operating personnel required to properly operate and maintain the facilities. Evaluations also were conducted using environmental criteria of a subjective nature to determine if the alternatives had potential to cause adverse or undesirable effects. Alternatives which

TABLE 4-18. SCREENING OF PRELIMINARY ALTERNATIVES DEVELOPED FOR THE FORT WORTH VILLAGE CREEK EIS.

Alternative Group	Screening Criteria	Energy Use (net Kw/hr/yr)	Operating Personnel	Length of Sewer(s) (miles)	Capital Cost (Millions)	O & M Cost (Millions)	Total Present Worth (M)	Compliance With 208	Reliability	Restricts Growth	Quantity of Sludge	Land Intensive	Resource Recovery	Air Emissions	Odor	Groundwater	Health Effects	Noise	Floodplain Effects	Implementation	Aesthetic Effects	Technical Feasbility	Regulations Compliance	Water Rights	Public Acceptance	Recommended for Further Consideration
1A	Nothing	0	0	0	0	0	0	X	X	X	X		X		X	X	X		X	X	X	X	X		X	•
1	Nothing (Interct)	0	0	68	41.3	4.3	45.6	X	X		X		X		X		X		X	X	X	X	X		X	
2	Expand VC	14.2	0	68	127.3	79.6	206.1				X		X		X			X			X					•
3	Satellite A	14.2	61	47	135.2	82.9	214.9	X			X		X		X			X			X				X	
4	Satellite B	13.4	80	58	134.2	81.9	214.7	X			X		X		X			X			X				X	
5	Satellite C	13.0	82	73	132.4	79.0	210.1	X			X		X		X			X			X				X	
6	Satellite D	14.3	38	67	87.2	79.2	202.3	X			X		X		X			X			X				X	
7	TRA (interim)	0	0	71	130.0	92.0	221.2	X					X							X						•
8	TRA (perm)	0	11	85	87.9	134.6	221.7	X		X			X							X					X	
9	Overland (f.p.)	22.3	8	68	195.2	75.1	239.6	X	X			X			X	X	X		X	X			X		X	
10	Overland (15 mi)	36.8	9	68	195.7	98.1	271.9	X				X			X	X	X								X	
11	Overland (30 mi)	50.5	10	68	216.5	115.7	313.4	X				X			X	X										•
12	Overland (137 mgd)	38.1	0	68	356.3	118.8	374.9	X	X			X			X	X	X		X	X			X			•
13	Overland (Sat A)	23.2	37	47	185.0	71.8	188.7	X				X			X	X	X								X	
14	Overland (Sat B)	23.1	41	58	194.6	80.2	244.2	X				X			X	X	X								X	
15	Overland (Sat C)	23.1	47	54	187.0	74.4	234.8	X				X			X	X	X								X	
16	Overland (Sat D)	22.3	25	67	195.6	77.0	241.8	X				X			X	X	X								X	
17	Irrig (25 mi)	33.7	19	68	222.3	140.9	255.0	X				X		X	X	X	X							X		•
18	Irrig (50 mi)	57.2	19	68	280.2	169.7	351.7	X				X		X	X	X	X							X		•
19	Rapid Infil (f.p.)	14.1	8	68	141.9	107.4	225.6	X				X	X		X	X			X	X		X	X		X	

X indicates a potential for adverse or undesirable characteristics or effects.

potentially would cause adverse effects are marked with a designator "X" (see Table 4-18) under the category evaluated.

As indicated in Table 4-18, the first alternative group, No Action, was included as required for full development in the EIS. Alternative group 2, expansion of the Village Creek WWTF to 137 mgd, would have associated increased noise levels and aesthetic (visual) impacts. Normal operation of a 137 mgd plant also would probably result in some odor generation; however, further study of the feasibility of implementing this alternative group was recommended.

Alternative groups 3,4, 5, and 6 center around utilization of several smaller "satellite" plants, in addition to maintaining a flow of 96 mgd at the Village Creek WWTF. Selection of this alternative grouping would result in smaller, localized odor problems. Public acceptance also would be sensitive locally. Therefore, these four broad-scale alternatives were dropped from further consideration.

Alternative groups 7 and 8 involve transferring a portion of the Village Creek WWTF's flow to the TRA Central WWTF in Grand Prairie. Alternative group 7 is a temporary diversion, while alternative group 8 is a permanent transfer.

TRA would charge the City of Fort Worth to treat its wastewater. Extra capacity at the TRA plant exists in order to accommodate the projected population increases in its rapidly urbanizing service area. A permanent linkage of the TRA plant with the Village Creek service area could act to inhibit growth in the TRA service area. Therefore, alternative group 8, the permanent transfer of flows, was dropped from further consideration while alternative group 7 was retained for consideration as a temporary solution (see Section 4.3.5 of this EIS).

Alternative groups 9 through 16 are all variations of land application of effluent. These alternatives would be very land-intensive, with a potential for odor and health effects. Alternative group 9 was rejected due to its location in the Trinity River floodplain. Alternative group 10 likewise was rejected because of its proximity (within 15 miles) to urban areas. Alternative groups 13, 14, 15, and 16 were eliminated due to the fact that they are simply land-intensive versions of alternative groups 3, 4, 5, and 6 (the satellite plant options) which also were eliminated. Alternative group 11 was proposed for further consideration because of the distance from the land application area (over 30 miles) from the urban area. Under Alternative 11, the Village Creek WWTF would be maintained at 96 mgd, and the additional 41 mgd treated via the overland flow process. In its original form, alternative group 12 was not proposed for further study because of its location in a floodplain. However, it was proposed that the concept of treating the entire design flow (137 mgd) by overland flow be further studied. Thus alternative group 12 was retained with the qualifier that a site sufficiently removed from the urban area and not in a floodplain would be located.

Alternative groups 17 and 18 employ the irrigation method of land application on sites located 25 and 50 miles from Fort Worth, respectively. Irrigation, like overland flow, is very land-intensive and has potential for odor, groundwater pollution, and health effects. A serious obstacle to implementation of this alternative potentially would involve legal water rights, since there would be limited return flow for downstream water users; however, it was recommended that these two alternative groups be considered further.

The final alternative group (19) involved a third type of land application, rapid infiltration of wastewater. Rapid infiltration requires sandy to gravelly soils, similar to those found in some areas adjacent to the Village Creek WWTF. However, soils near the Village Creek WWTF are primarily in the floodplain, thus discouraging this location. It was recommended that no further consideration of this alternative group be made unless a suitable upland site could be located.

Upon completion of the evaluation of the preliminary alternatives, the following seven treatment concepts (i.e., alternative groups) were designated for further consideration:

(1) Group 1A - Do nothing (i.e., the no action alternative).

(2) Group 2 - Expand Village Creek WWTF to 137 mgd.

(3) Group 7 - Maintain Village Creek at 96 mgd and temporarily transfer excess flows to the TRA Central WWTF.

(4) Group 11 - Maintain Village Creek WWTF at 96 mgd and treat 41 mgd using overland flow within 30 miles of Village Creek WWTF.

(5) Group 12 - Utilize Village Creek for primary treatment of 137 mgd followed by overland flow treatment of 137 mgd, but at a distant site in lieu of the Trinity River floodplain.

(6) Group 17 - Maintain Village Creek WWTF at 96 mgd and treat 41 mgd by slow rate irrigation within 25 miles of Village Creek WWTF.

(7) Group 18 - Maintain Village Creek WWTF at 96 mgd and treat 41 mgd by slow rate irrigation within 50 miles of Village Creek WWTF.

Sludge treatment and disposal options and components were not evaluated in detail at the preliminary alternatives stage. Eight process groups for sludge treatment and disposal were identified from the components described previously (Section 4.4.5), and all eight process groups were considered applicable to all 19 preliminary alternative groups. An evaluation was made of six sludge disposal techniques: (1) bag and market as fertilizer; (2) agricultural landspreading; (3) give-away for private citizen use (horticulture); (4) dedicated land disposal; (5) landfilling; and (6) lagooning. The concept of bagging and marketing dried sludge as fertilizer was not proposed for further study, simply on economic grounds. There would be a fluctuating demand for the product (high in spring, low in winter), and the volume of sludge generated at the Village Creek WWTF would be too large. However, agricultural landspreading was found to be environmentally acceptable and was retained for further consideration as a base alternative. Horticultural use was not recommended for further study, also on economic grounds and due to the fact the system could be unreliable (i.e., what does one do if no one comes to take away the free sludge?). Dedicated land disposal, whereby liquid sludge would be applied to a particular tract of land through continuous plowing, was retained for further consideration. Landfilling of dried sludge also was retained as a base alternative. Landfilling of sludge, at a content of 15 percent solids or higher, is a reliable disposal method and also was retained as an alternative. Lagooning of liquid sludge was not recommended for further study due to potential health effects, groundwater impacts, and unreliability of the system. The evaluation of sludge disposal options is summarized in Table 4-19.

TABLE 4-19. MATRIX OF BASE SLUDGE DISPOSAL OPTIONS FOR THE FORT WORTH EIS

Utilization/ Disposal Options	Evaluation Criteria				Acceptable For Base Alternative
	Reliability	Environmental Impacts	Site Availability	Cost	
Bag-market as Fertilizer	X	-	-	X	X
Agricultural Landspreading	-	-	-	-	●
Give to Citizens (horticulture)	X	-	-	-	X
Dedicated Land Disposal	-	-	-	-	●
Landfill	-	-	-	-	●
Lagooning	X	X	-	-	X

X = Unacceptable

- = Acceptable

● = Recommended as an acceptable disposal practice

An analysis also was made of components (i.e., sludge treatment processes) that would be required prior to the disposal concepts which were evaluated. For example, it was important to recognize that landfilling typically requires sludge to undergo four treatment processes, whereas sludge can be injected as a liquid at a dedicated land disposal site following only two treatment processes. Treatment components (i.e., processes) typically required prior to ultimate disposal of sludge are presented in Table 4-20. As indicated by Table 4-20, (1) landspreading of sludge in areas not involving significant human contact, (2) landfilling, and (3) dedicated land disposal all were selected for further consideration as sludge disposal options.

Wastewater effluent reuse also was evaluated at the preliminary alternatives stage. Three reuse concepts determined to be feasible for evaluation were: (1) golf course irrigation; (2) municipal water supply; and (3) industrial use as makeup water or cooling water.

The City determined that several golf courses such as Arlington Municipal, Shady Valley, Rolling Hills, Sotogrande, Pecan Valley, Worth Hills, Colonial, Ridglea, Shady Oaks, Z. Boaz, Sycamore, Meadow Brook, Woodhaven, Diamond Oaks, and Mansfield golf courses all were within 4 mi of the Village Creek WWTF or one of the various satellite plant locations chosen for evaluation. It also was determined that typical, well-maintained golf courses with fairway sprinkler systems use approximately 175,000 gpd (or 0.175 mgd) of water for irrigation (CDM et al. 1981a). On this basis, it was determined that nearby golf courses would utilize between 0.7 and 1.8 mgd of irrigation water, depending on the exact number of golf courses nearby for each particular alternative group. Peak usage rates during periods of irrigation would range between 2.5 and 6.5 mgd. It was concluded that golf course irrigation systems, which would only utilize 1.8 mgd out of 137 mgd of wastewater generated, would not be economically feasible. Thus concepts of wastewater reuse for golf course irrigation were dropped from further consideration.

A review of Fort Worth's industrial water consumption and waste discharge records revealed no major potential users of wastewater effluent (CDM et al. 1981a). In addition, officials of the Texas Electric Service Company (TESCO) power plant on Lake Arlington stated that they had studied the possibility of

TABLE 4-20. DETERMINATION OF SLUDGE COMPONENTS TYPICALLY REQUIRED FOR VARIOUS SLUDGE DISPOSAL PROCESSES AND SELECTION OF DISPOSAL PROCESSES FOR FURTHER CONSIDERATION

THICKENING	STABILIZATION	CONDITIONING	DEWATERING	DRYING	DISINFECTION	REDUCTION	TRANSPORTATION	ULTIMATE DISPOSAL	SELECTED FOR FURTHER CONSIDERATION
R	R	R	R	R	R		R	LANDSPREAD (HUMAN CONTACT)	
R	R	R	R				R	LANDSPREAD (NON-CONTACT)	●
R	R	R	R				R	LANDFILL	●
R	R						R	DEDICATED LAND DISPOSAL	●

R = Indicates a required component

using treated effluent for cooling water and other uses and found it to be uneconomical (CDM et al. 1981a). Therefore, the concept of industrial reuse of wastewater was dropped from further consideration.

The City of Fort Worth obtains drinking water from the Tarrant County Water Control and Improvement District (WCID) No. 1. The Tarrant County WCID No. 1 obtains approximately 150 mgd of raw water from Cedar Creek Lake, which is located northeast of Corsicanna approximately 85 miles from Fort Worth, and pumps it to Fort Worth for treatment and use by Fort Worth and other cities. In addition, the Tarrant County WCID No. 1 is planning development of Richland-Chambers Lake, located southeast of Corsicanna about 80 miles from Fort Worth, as a source of an additional 187 mgd raw water supply (CDM et al. 1981a). Studies by engineering consultants for the City of Arlington determined that utilization of Village Creek WWTF effluent as a raw water source was feasible, and potentially could avoid the need for constructing all or portions of the Richland-Chambers project at a savings of $165,218,000 in terms of July 1980 dollars (Sheaffer and Roland 1981). However, statements given by a representative of Tarrant County WCID No. 1 at CAC Meeting No. 10 (held on 17 December 1981) indicated that land purchases for the Richland-Chamber project were 42 percent complete, all monies required for the reservoir project were allocated, and that the entire reservoir project would be built and utilized for raw water supplies regardless of the availability of Village Creek WWTF effluent. Therefore, it was determined by the City that utilization of Village Creek WWTF effluent for potable water supplies currently was not economically feasible, and thus the concept of using wastewater for municipal raw water supply was dropped from further consideration.

4.6 DEVELOPMENT AND SCREENING OF INTERMEDIATE ALTERNATIVES

4.6.1 Development of Intermediate Alternatives

Fifteen intermediate alternatives were selected by the City for further evaluation as a result of the screening of the 19 preliminary alternative groups. The 15 intermediate alternatives were derived primarily from the seven preliminary alternative groups selected for further consideration. The City selected one satellite plant concept for further evaluation, even though the general concept of sewage treatment at satellite plants was eliminated by the preliminary alternatives screening. The 15 alternatives selected for evaluation are identified in Table 4-21. Figure 4-6 illustrates five sewage treatment and/or sludge disposal sites associated with the 15 intermediate alternatives. Complete detailed descriptions of each of the 15 intermediate alternatives are contained in the report entitled "Fifteen Alternatives for Intermediate Screening" prepared by the City's consulting engineers (CDM et al 1981b).

As indicated in Table 4-21 the 15 intermediate alternatives were grouped into four groups, labeled A through D. All Group A alternatives would involve conventional advanced treatment. Alternatives 1-4 would involve expansion of the Village Creek WWTF (Site 2) to 137 mgd, and would differ only in the manner of ultimate sludge disposal (i.e., drying beds at Site 2 or dedicated land disposal, landspreading, or landfill at Site 1). Alternatives 13 and 14 would involve maintaining Village Creek at 96 mgd, and transferring the excess 41 mgd to the TRA Central WWTF on a temporary and permanent basis, respectively.

With alternatives 13 and 14, sludge would be disposed by landspreading at Site 1. Alternative 15 would involve treating 132 mgd at the Village Creek WWTF and 5 mgd at the Silver Creek satellite plant, with sludge from Village Creek disposed by dedicated land disposal at Site 1 and sludge from Satellite Creek dried on drying beds at Site 5 and then disposed via use as a soil conditioner.

Group B alternatives would involve treatment of all or part of the design flow by slow rate irrigation (land treatment). Alternative 5 would involve treatment of 96 mgd at Village Creek with sludge disposed by landspreading at Site 1, and treatment of 41 mgd by slow rate irrigation at Mustang Creek (Site 3) with sludge disposed by landspreading at the same site. Alternative 6 was similar, but would involve passing 137 mgd through the existing Village Creek WWTF (96 mgd capacity) and then conveying all 137 mgd to Mustang Creek (Site 3) for treatment by slow rate irrigation. Sludge from Village Creek would be disposed by landspreading at Site 1, and sludge generated at Mustang Creek would be disposed on-site via landspreading. Alternatives 11 and 12 would involve pumping all 137 mgd directly to Mustang Creek (Site 3) or Mountain

TABLE 4-21. FIFTEEN INTERMEDIATE ALTERNATIVES SELECTED FOR EVALUATION IN THE FORT WORTH

	CONVENTIONAL TREATMENT PLANTS ADF & QUALITY					MUSTANG CREEK SITE-A ADF & QUALITY			MOUNTAIN CREEK SITE-B ADF & QUALITY			LAND SITES	TOTAL SYSTEM		ASSOCIATED SLUDGE ALTERNATIVE FOR FT. WORTH							
																	SLUDGE FOR FINAL DISPOSAL (TPD)					
ALTERNATIVE NO	VCP FLOW (MGD)	TRA FLOW (MGD)	SILVER CREEK FLOW (MGD)	EFFLUENT TO	EFFLUENT BOD/TSS LESS THAN (MGL)	INFLUENT FROM	ADF (MGD)	EFFLUENT BOD/TSS LESS THAN (MG/L)	INFLUENT FROM	ADF (MGD)	EFFLUENT BOD/TSS LESS THAN (MG/L)	EFFLUENT TO	ADF (MGD)	EFFLUENT BOD/TSS LESS THAN (MG/L)	SLUDGE ALTERNATIVE NO.	DESCRIPTION	AT VCP	AT TRA	AT SILVER CREEK	AT LAND SITE	TOTAL RAW	TOTAL FOR DISPOSAL (FT. WORTH ONLY)
GROUP A - CONVENTIONAL TREATMENT ONLY																						
1	137	0	0	TRINITY RIVER	10/15	–	–	–	–	–	–	–	137	10/15	101	EXPAND SLUDGE DRYING BEDS	217	–	–	–	217	126
2	137	0	0			–	–	–	–	–	–	–	137		102	DEDICATED LAND DISPOSAL	217	–	–	–	217	126
3	137	0	0			–	–	–	–	–	–	–	137		109	LAND APPLICATION	217	–	–	–	217	126
4	137	0	0			–	–	–	–	–	–	–	137		106	LANDFILL	217	–	–	–	217	126
15	132	0	5			–	–	–	–	–	–	–	137		103	DEDICATED LAND DISPOSAL & DRYING BEDS	208	–	7	–	208	121
13 & 14	96	41	0			–	–	–	–	–	–	–	137		110	LAND APPLICATION	152	UNKNOWN	–	–	–	89
GROUP B - CONVENTIONAL FOLLOWED BY SLOW RATE LAND APPLICATION																						
5	96	0	0	RIVER	10/15	VCP	41	10/15	–	–	–	LAKE BENBROOK	137	10/15	111	LAND APPLICATION	163	–	–	19	182	114
6	137	0	0	SITE-A	70/70	VCP	137	10/15	–	–	–	LAKE BENBROOK	137		112	LAND APPLICATION	185	–	–	17	202	123
11	108	0	0	SITE-A	275/295	VCP	137	10/15	–	–	–	LAKE BENBROOK	137		113	LAND APPLICATION	–	–	–	86	86	86
12	108	0	0	SITE-B	275/295				VCP	137	10/15	LAKEVIEW RES.	137		114	LAND APPLICATION	–	–	–	86	86	86
GROUP C - CONVENTIONAL FOLLOWED BY OVERLAND FLOW																						
9	96	0	0	RIVER	10/15	–	–	–	VCP	41	10/15	LAKEVIEW RES.	137	10/15	107	LANDFILL	163	–	–	0	163	95
10	137	0	0	SITE-B	70/70				VCP	137	10/15	LAKEVEIW RES.	137	10/15	108	LANDFILL	185	–	–	0	185	107
GROUP D - CONVENTIONAL FOLLOWED BY RAPID INFILTRATION																						
7	96	0	0	RIVER	10/15	NO RAPID INFILTRATION SITES ARE AVAILABLE						N/A	137	10/15	104	DEDICATED LAND DISPOSAL	163	–	–	19	182	114
8	137	0	0	SITE-C	70/70	WHICH MEET THE CRITERIA (SEE TEXT)						N/A	137	10/15	105	DEDICATED LAND DISPOSAL	185	–	–	17	202	123

SOURCE: CDM et al. 1983.

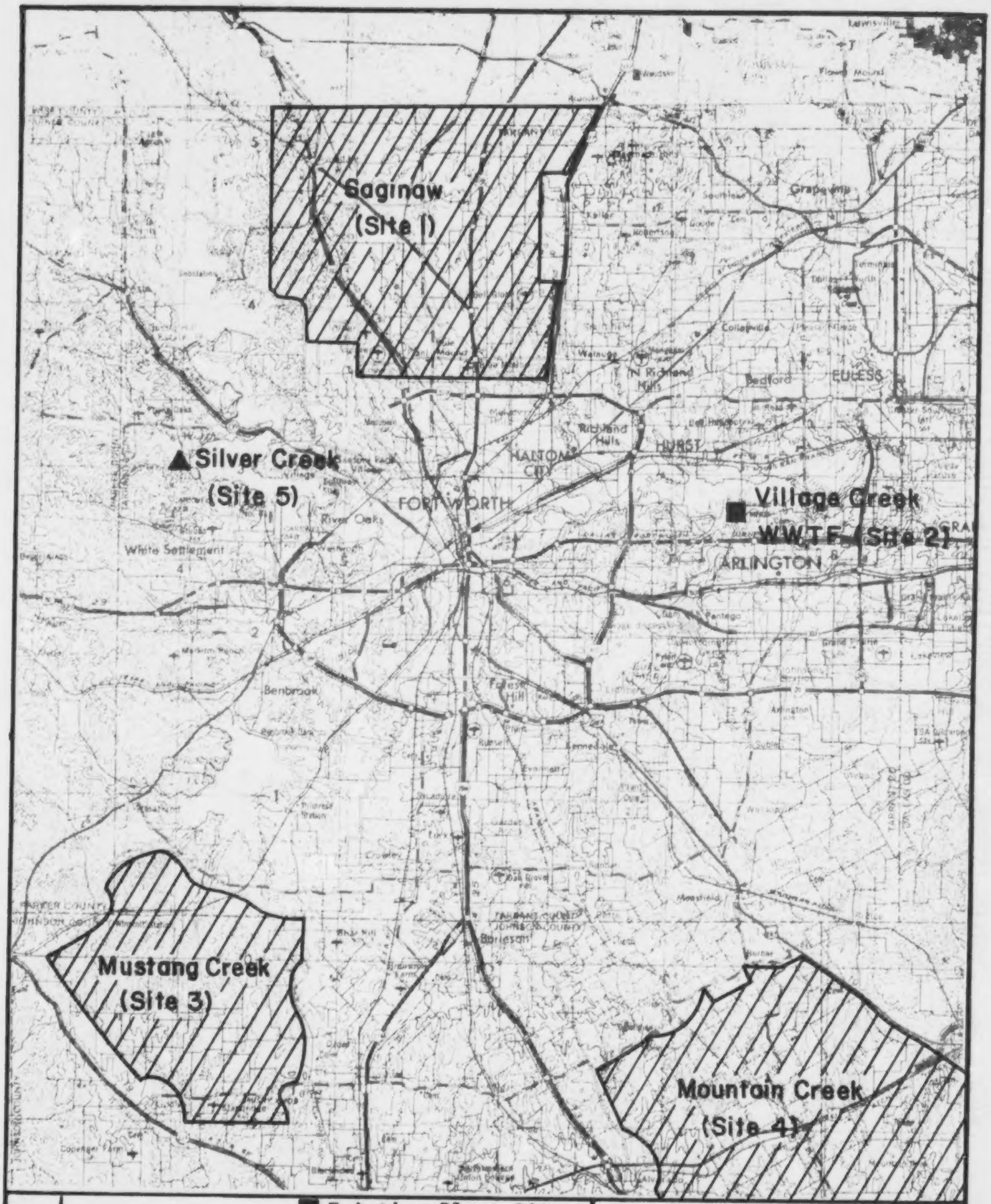

FIGURE 4-6. TREATMENT PLANT SITES ASSOCIATED WITH 15 INTERMEDIATE ALTERNATIVES (SOURCE: CDM et al. 1981b).

Creek (Site 4), respectively, for treatment by slow rate irrigation. Sludge generated at the irrigation sites would be disposed by landspreading on-site.

Group C alternatives would involve treatment by overland flow (land treatment). Alternative 9 would involve treatment of 96 mgd at the Village Creek WWTF with sludge disposed by landfilling at Site 1, plus treatment of 41 mgd at Moutain Creek (Site 4) by overland flow. Alternative 10 would involve passing 137 mgd through the existing 96 mgd capacity Village Creek WWTF, and then conveying all 137 mgd to Mountain Creek for treatment by overland flow. Sludge from the Village Creek WWTF would be disposed by landfilling at Site 1.

Group D alternatives would be identical to the Group C alternatives, except treatment by rapid infiltration (land treatment) instead of overland flow would be used, and sludge would be disposed at Site 1 by dedicated land disposal. However, suitable sites meeting all design criteria for utilization of rapid infiltration technology could not be located.

4.6.2 Treatment Technologies for Intermediate Alternatives

Numerous treatment process options and technologies were evaluated during the preliminary alternatives screening process. In general, only the most cost-effective and environmentally sound processes were selected as part of the 15 intermediate alternatives. In addition, several "key issues" regarding treatment plant operation and maintenance problems were addressed during this stage of the planning process.

As mentioned in Section 4.4.3.1, the existing Village Creek WWTF does not provide for removal of sand and grit at the head (beginning) of the plant, as is commonly done at other treatment facilities. The process was described in the City's engineering report (CDM et al. 1981b) prepared during this phase of planning in the following manner:

> "The sewage does not pass through any grit removal process prior to settling although detritors do exist at the old plant. The settled sludge from the primary clarifiers is removed in a dilute solution of about 1.0% solids so that it can be processed through sludge grinders and cyclone degritters. Grit removal prior to settling would allow sludge to be drawn off at a solids concentration of

around 4% because the need for cyclone degritters would be eliminated. This would provide for easier handling."

It also was believed that grit removal at the head of the plant would extend equipment life and reduce maintenance problems of numerous sludge handling mechanisms. Thus, nine new aerated grit basins were proposed for all intermediate alternatives involving expansion of the Village Creek WWTF to 137 mgd capacity, and five new aerated grit basins were proposed for all alternatives involving maintaining the Village Creek WWTF at 96 mgd capacity.

Gravity settling in primary clarifiers was chosen to remain as the primary treatment process to be utilized, mainly because the system is reliable and presently used at the Village Creek WWTF. No new units would be required to maintain a 96 mgd capacity, and two new units would be required for expansion to a 137 mgd capacity. Similarly, activated sludge followed by final clarification was proposed for utilization for secondary treatment at the Village Creek WWTF, since these processes also are currently used. To provide adequate secondary treatment at the 96 mgd Village Creek WWTF one new aeration basin (i.e., activated sludge unit) and five new final clarifiers would be required, while for 137 mgd, four aeration basins and eight new clarifiers would be utilized. Conventional advanced treatment would be acheived by dual-media filtration units similar to those currently at the plant. Eight additional units would be required to enable consistent compliance with proposed discharge permit standards at the present plant capacity, while 18 additional units would be required for expansion of the Village Creek WWTF to 137 mgd.

Odor control was identified as a key issue by the City, the CAC, and the general public. Numerous complaints have been lodged by nearby residents concerning odors generated by the existing Village Creek WWTF, the sludge drying beds, and the current odor masking (i.e., perfume) system used by the City. The City therefore proposed the following odor control processes as part of all 15 intermediate alternatives (CDM et al. 1981b):

- All pretreatment, primary, gravity and flotation thickeners, and sludge dewatering facilities would be covered and exhaust air from these units would be scrubbed using potassium permanganate, activated carbon or other oxidizing chemicals now commercially available. The scrubber system would chemically change odor causing compounds to non-odorous, non-objectionable compounds. The new unobjectionable compounds would be returned to the plant and the scrubbed air would be vented to the atmosphere; and

- Process improvements also would be made. The cause of odors presently generated are mostly due to an inadequate and unreliable solids handling system. A part of the upgrading or expansion of the Village Creek WWTF as proposed in the draft facilities plan would involve upgrading the system by (1) adding new aerated grit removal facilities, (2) adding adequate and reliable sludge thickening facilities, and (3) improving treatment of secondary and recycle flows.

Sludge treatment processes selected for utilization at an upgraded (96 mgd) or expanded (137 mgd) Village Creek WWTF also would basically be the same as those currently utilized. Waste activated sludge would be thickened primarily by dissolved air flotation units instead of additional centrifuge units. Thickened sludge would be stablized in additional anaerobic digestors, supplied with additional energy recovery (methane gas recovery) and gas utilization systems.

Sludge disposal for all alternatives except Alternative 1 would involve disposal at distant sites, primarily Site 1 north of Saginaw. Transportation of sludge via pipeline, truck, and rail were evaluated (Table 4-22). To dispose of liquid sludge via landspreading or dedicated land disposal (both processes would involve injecting liquid sludge approximately six inches underground), the most cost-effective sludge transportation system would be via pipeline (pumping liquid sludge) to the disposal site. To dispose of dried sludge by landspreading or landfilling, the most cost-effective transportation system would again involve piping sludge to the disposal site (Site 1), followed by dewatering on sludge drying beds. Thus, pumping sludge through pipeline(s) to Site 1 for disposal by landspreading (liquid or solid), dedicated land disposal (liquid), or landfilling (solid) was selected as the best transportation system for utilization with all 15 intermediate alternatives (with exception of Alternative 1 which involves the present system of pumping sludge via pipeline to the drying beds near the Village Creek WWTF).

TABLE 4-22. EVALUATION OF MOST COST-EFFECTIVE SLUDGE TRANSPORTATION SYSTEM TO BE UTILIZED WITH 15 INTERMEDIATE ALTERNATIVES

Type of Sludge and Transportation Method	Form of Ultimate Use	Dewatering Method	Transportation Cost		Dewatering Cost		Total Cost
			Capital	O&M	Capital	O&M	
2% Slurry in pipeline	5-8% Slurry	Lagoon	14.82	22.40	0.92	3.42	41.56
	22% Solid	Belt Filter	14.82	22.40	14.23	28.10	79.55
	40% Solid	Sludge Dry Bed	14.82	22.40	5.84	9.11	52.17
Truck - Solid Form							
	22% Solid	Belt Filter	17.42	44.93	14.23	28.10	104.68
	40% Solid	Filter Press	9.58	24.68	36.48	34.93	105.67
Rail - Solid Form							
	22% Solid	Belt Filter	15.76	40.88	14.23	28.10	98.97
	40% Solid	Filter Press	8.67	22.53	36.48	34.93	102.61

* Transportation distance is 24 miles.

** Capital cost is current, 1981 Cost. O&M Cost is present worth

SOURCE: CDM et al. 1983.

4.6.3 Screening of Intermediate Alternatives

The 15 intermediate alternatives selected by the City for evaluation were analyzed (or screened) by again using both engineering and environmental criteria. However, for this evaluation a multidisciplinary team evaluated each alternative for specific adverse effects in the following categories:

- Earth Resources
- Water Resources
- Air Resources
- Biological Resources
- Cultural Resources
- Socioeconomics

The alternatives also were evaluated with respect to system feasibility, implementability, reliability, and cost. Detailed evaluation matrixes illustrating the results of the multidisciplinary evaluations are contained in a memorandum entitled "Draft Environmental Screening of 15 Intermediate Alternatives" prepared for the City by WAPORA, Inc. (WAPORA, Inc. 1981). The 15 alternatives also were evaluated by the CAC and a CAC subcommittee.

As a result of evaluations by the multidisciplinary team and by the CAC, Alternative 1 was dropped due to concern for odors which would be produced by expanded drying beds adjacent to the Village Creek WWTF. Similarly, Alternative 2 was eliminated over concern for fugitive dust and odors which potentially would be caused by dedicated land disposal operations at the sludge disposal site north of Saginaw (Site 1). Alternative 6 involving land treatment of 137 mgd by slow rate irrigation at Mustang Creek (Site 3) was eliminated due to concerns over water rights and due to the fact that difficulties arose in finding enough landowners (owning 28,300 acres of land) to willingly participate in an irrigation program. Alternatives 7 and 8 were eliminated because no suitable lands (outside of the Trinity River floodplain) could be located for utilization of the rapid infiltration method of land treatment. Alternatives 9 and 10 were eliminated because overland flow treatment, or for that matter any land treatment technique, at the Mountain Creek site (Site 4) near Venus, Texas was found to be totally unacceptable to surrounding landowners and residents. Alternatives 11 and 12, involving land treatment of 137 mgd by slow rate irrigation at Mustang Creek (Site 3) and

Mountain Creek (Site 4) respectively, also were eliminated due to unavailability of land and/or the unwillingness of landowners to cooperate in irrigation programs. Alternative 13, the concept of temporarily transferring flows to the TRA Central WWTF, was found acceptable and as a result was made part of all alternatives (see Section 4.3.5 of this EIS).

Alternative 14, the concept of permanently transferring flows to the TRA Central WWTF, was eliminated after further negotiations indicated that this alternative would not be acceptable to the TRA. Alternative 15 was eliminated due to concerns over potential environmental effects (particularly odor, fugitive dust, and noise) in the vicinity of the proposed Silver Creek satellite plant, and due to the fact that further preliminary engineering studies conducted by CDM indicated that the Silver Creek WWTF potentially would not receive an average daily flow of 5 mgd during the planning period. Population projections issued in 1981 by NCTCOG (refer to Table 4-4) indicated that the Lake Worth Dam watershed (within which sewage contributed to the Silver Creek satellite WWTF would be generated) would not increase in population at the rate anticipated by CDM, thus further substantiating the fact that anticipated sewage flows would not justify existence of a Silver Creek WWTF.

Evaluation of the engineering feasibility and implementability of the remaining alternatives found the treatment concepts to be basically sound. It was noted that the concept of land treatment by overland flow was eliminated due to the fact that landowners and residents in the vicinity of Mountain Creek (Site 4) were very opposed to any sewage treatment facilities in their area, and not due to environmental or engineering limitations of the overland flow treatment process.

It was recommended that the City evaluate the concept of land treatment by slow-rate irrigation at the Mustang Creek site (Site 3) or other suitable sites. It also was recommended that the concept of purchasing land for land treatment systems be considered in addition to the concept of leasing land as previously evaluated. With these recommendations, the following three alternative concepts remained for detailed development and evaluation:

(1) Expand the Village Creek WWTF to treat 137 mgd, and dispose of sludge by landspreading on agricultural lands north of Saginaw (Site 1).

(2) Expand the Village Creek WWTF to treat 137 mgd, and dispose of sludge by landfilling in a municipal refuse landfill (co-disposal) north of Saginaw (Site 1).

(3) Maintain the Village Creek WWTF at 96 mgd, dispose of sludge from the Village Creek WWTF by landspreading north of Saginaw (Site 1), and treat 41 mgd of sewage by land treatment using slow rate irrigation at Mustang Creek (Site 3).

4.7 DESCRIPTION OF FINAL ALTERNATIVES

Final alternatives for detailed evaluation were developed based upon the three concepts remaining after screening the 15 intermediate alternatives. Initially, three final alternatives were developed for evaluation. Based upon public input, a modification to the second final alternative was later developed for evaluation. This section describes the three final alternatives plus the modified alternative chosen for evaluation. Detailed environmental evaluations of the final alternatives are contained in Chapter 5.0 of this EIS.

4.7.1 Description of Alternative 1

Alternative 1 would involve expansion of the Village Creek WWTF (Site 2) to a capacity of 137 mgd. Sludge generated at the WWTF would be mechanically dewatered at the WWTF and transported by truck to a target area north of Saginaw (Site 1) for disposal by landspreading (Figure 4-7). A detail of the sludge disposal target area is illustrated in Figure 4-8. Details of the liquid treatment and sludge treatment units which would be involved with expansion of the Village Creek WWTF to a 137 mgd capacity are described below, followed by a description of the sludge disposal system associated with Alternative 1.

4.7.1.1 Liquid Treatment for Alternative 1

Liquid treatment at an expanded 137 mgd Village Creek WWTF would consist of coarse screening, primary sedimentation, activated sludge secondary treatment, dual media filtration advanced treatment, and disinfection by chlorination prior to effluent discharge to the Trinity River. The expanded plant would

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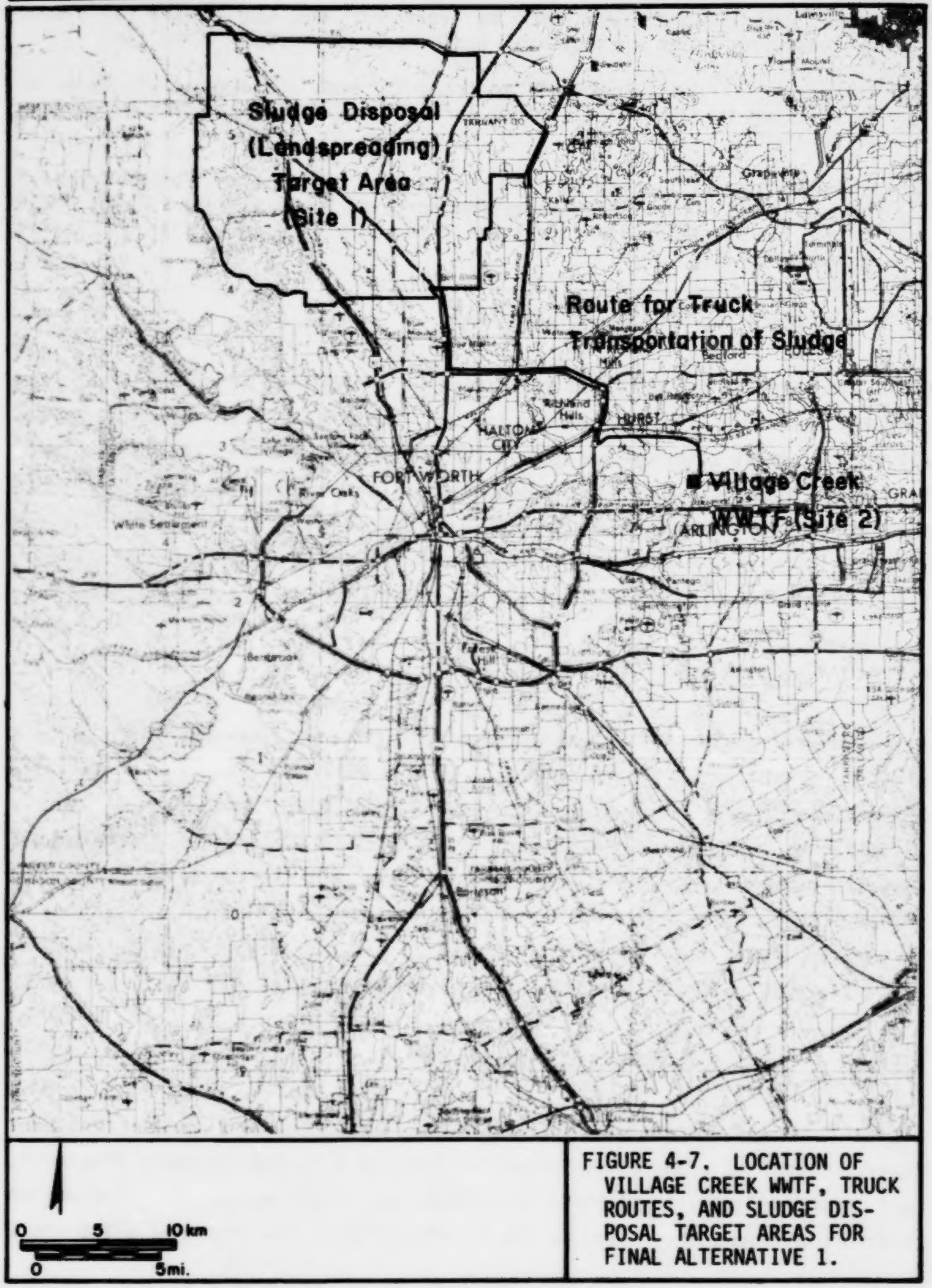


FIGURE 4-7. LOCATION OF VILLAGE CREEK WWTF, TRUCK ROUTES, AND SLUDGE DISPOSAL TARGET AREAS FOR FINAL ALTERNATIVE 1.

SOURCE: ADAPTED FROM CDM et al. 1982.

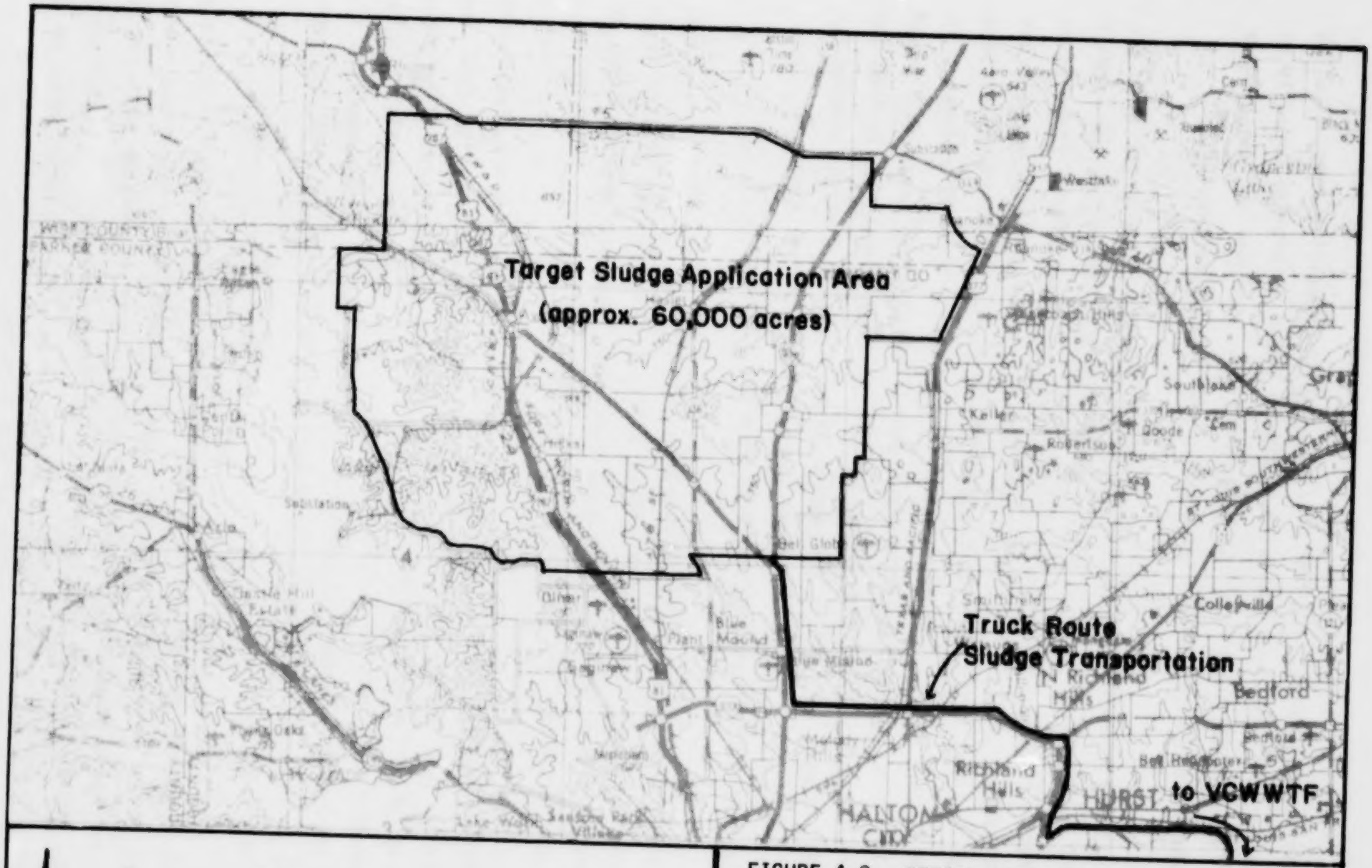


FIGURE 4-8. DETAIL OF SLUDGE DISPOSAL (LANDSPREADING) TARGET AREA FOR FINAL ALTERNATIVE 1 (SOURCE: CDM et al. 1982).

utilize existing equipment to the greatest extent possible, some existing units would be modified, and new units would be added to provide capacity as required. Table 4-23 indicates existing, modified, and new equipment which would be needed for proper liquid treatment of 137 mgd of wastewater.

Locations of the proposed new treatment units at the Village Creek WWTF are illustrated in Figure 4-9. A schematic line diagram illustrating the path of the wastewater through the plant is illustrated in Figure 4-10. Flows to be treated at average daily flow (ADF), nominal daily flow (NDF) or worse month daily flow, maximum daily flow (MDF), and two-hour peak flow (2HP) conditions and the estimated quality of effluent from each unit also is indicated in Figure 4-10. The proposed 137 mgd expansion of the Village Creek WWTF would be designed to meet 10/15 effluent limitations for both average daily flow and nominal flow conditions. Some wastewater flows would be diverted around the secondary treatment (i.e., activated sludge) and advanced treatment (i.e., dual media filtration) units during high flow conditions.

Most of the new treatment units proposed for the Village Creek WWTF are simply additional units which are exactly like units at the existing Village Creek WWTF, would perform the same treatment funcitons, and are needed simply to handle the increased flows from 96 mgd to 137 mgd.

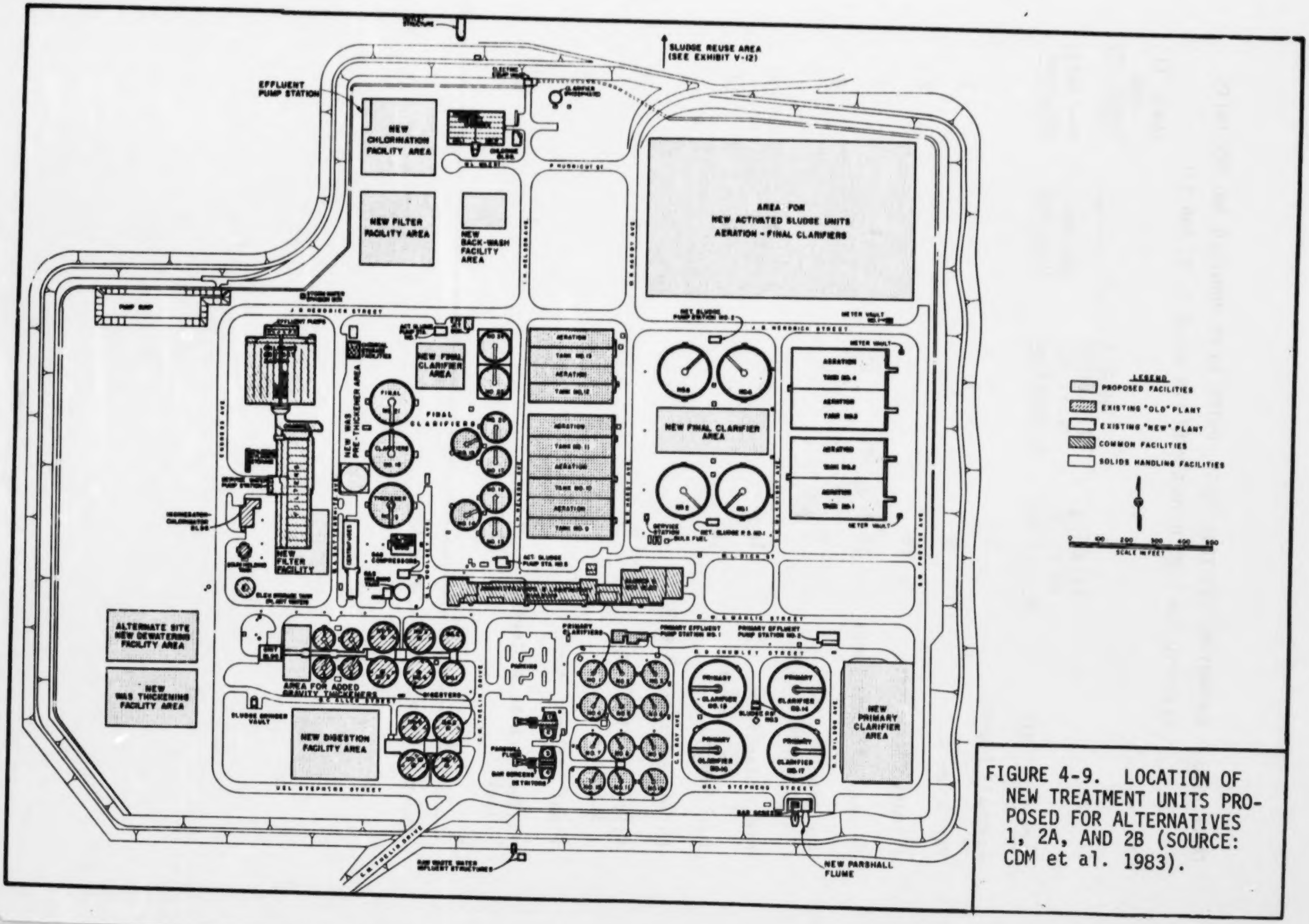
New filter backwash storage tanks would be required to avoid hydraulically and biologically overloading the treatment processes. Backwash water from the filters would be pumped directly into these backwash storage tanks. The tanks would perform two functions: (1) temporary storage; and (2) partial liquid/solids separation. Chemical addition facilities would be incorporated and would be used for pH adjustment, chlorination, lime, ferric chloride, polymer, and oxidant addition.

All new treatment units at the Village Creek WWTF would be built inside of existing dikes surrounding the plant and constructed to elevation 484.0. Recent hydraulic studies (USCOE 1983a) indicate that a 100-year flood in the vicinity of the Village Creek WWTF would reach approximately elevation 478.8, and the 500-year flood would reach 483.9; thus, all treatment units at the Village Creek WWTF would be protected from flooding.

TABLE 4-23. SUMMARY OF EXISTING UNITS, UNITS TO BE MODIFIED AND NEW UNITS REQUIRED FOR LIQUID TREATMENT FOR PHASE I, II AND III

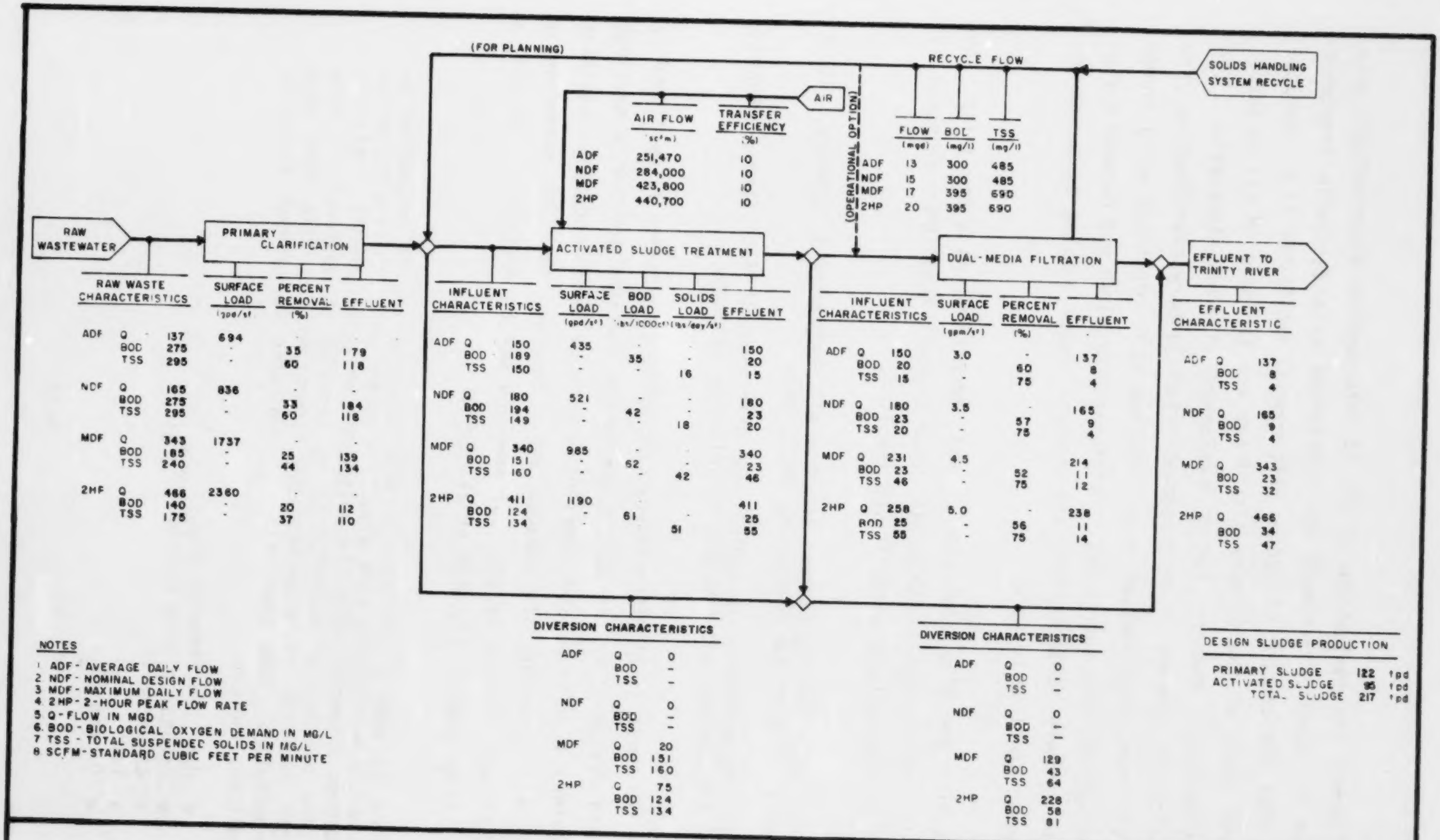
	PHASE I			PHASE II AND PHASE III
Treatment Unit	Existing Units To Be Utilized	Existing Units To Be Modified	New Units Required	New Units Required
Parshall Flumes	6		1	
Bar Screens	9	4		3
Primary Clarifiers	16			2
Primary Effluent Pumps	11		1	1
Aeration Basins (Activated Sludge)	9			3
Final Clarifiers	12	3	3	6
Dual Media Filters	14		6	12
Chlorine Contact Basins	4			2
Filtered Water Pump Station	0		1	1
Final Effluent Pumps	5			5
Filter Back-Wash Storage Tank	0		1	1

SOURCE: ADAPTED FROM CDM 1983b.



SLUDGE REUSE AREA (SEE EXHIBIT V-12)
EFFLUENT PUMP STATION
NEW CHLORINATION FACILITY AREA
NEW FILTER FACILITY AREA
NEW BACK-WASH FACILITY AREA
AREA FOR NEW ACTIVATED SLUDGE UNITS AERATION - FINAL CLARIFIERS
J B HENDRICK STREET
NEW FINAL CLARIFIER AREA
FINAL CLARIFIERS
NEW WAS PRE-THICKENER AREA
THICKENER
GAS COMPRESSORS
NEW FILTER FACILITY
INCINERATOR-CHLORINATOR BLDG
AERATION
TANK NO. 13
TANK NO. 12
TANK NO. 11
TANK NO. 10
TANK NO. 9
TANK NO. 4
TANK NO. 3
TANK NO. 2
TANK NO. 1
ACT. SLUDGE PUMP STA. NO. 3
METER VAULT
ALTERNATE SITE NEW DEWATERING FACILITY AREA
NEW WAS THICKENING FACILITY AREA
AREA FOR ADDED GRAVITY THICKENERS
DIGESTERS
SLUDGE GRINDER VAULT
NEW DIGESTION FACILITY AREA
PRIMARY CLARIFIERS
PRIMARY EFFLUENT PUMP STATION NO. 1
PRIMARY EFFLUENT PUMP STATION NO. 2
PRIMARY CLARIFIER
NEW PRIMARY CLARIFIER AREA
PARSHALL FLUME
BAR SCREENS
NEW PARSHALL FLUME
RAW WASTE WATER INFLUENT STRUCTURES
C.W. THELIN DRIVE
LEGEND
PROPOSED FACILITIES
EXISTING "OLD" PLANT
EXISTING "NEW" PLANT
COMMON FACILITIES
SOLIDS HANDLING FACILITIES
0 100 200 300 400 500
SCALE IN FEET

FIGURE 4-9. LOCATION OF NEW TREATMENT UNITS PROPOSED FOR ALTERNATIVES 1, 2A, AND 2B (SOURCE: CDM et al. 1983).



		RAW WASTE CHARACTERISTICS	SURFACE LOAD (gpd/sf)	PERCENT REMOVAL (%)	EFFLUENT
ADF	Q	137	694	-	-
	BOD	275	-	35	179
	TSS	295	-	60	118
NDF	Q	165	836	-	-
	BOD	275	-	33	184
	TSS	295	-	60	118
MDF	Q	343	1737	-	-
	BOD	185	-	25	139
	TSS	240	-	44	134
2HF	Q	466	2360	-	-
	BOD	140	-	20	112
	TSS	175	-	37	110

		INFLUENT CHARACTERISTICS	SURFACE LOAD (gpd/sf)	BOD LOAD (lbs/1000cf)	SOLIDS LOAD (lbs/day/sf)	EFFLUENT
ADF	Q	150	435	-	-	150
	BOD	189	-	35	-	20
	TSS	150	-	-	16	15
NDF	Q	180	521	-	-	180
	BOD	194	-	42	-	23
	TSS	149	-	-	18	20
MDF	Q	340	985	-	-	340
	BOD	151	-	62	-	23
	TSS	160	-	-	42	46
2HP	Q	411	1190	-	-	411
	BOD	124	-	61	-	25
	TSS	134	-	-	51	55

	AIR FLOW (scfm)	TRANSFER EFFICIENCY (%)
ADF	251,470	10
NDF	284,000	10
MDF	423,800	10
2HP	440,700	10

	FLOW (mgd)	BOL (mg/l)	TSS (mg/l)
ADF	13	300	485
NDF	15	300	485
MDF	17	395	690
2HP	20	395	690

		INFLUENT CHARACTERISTICS	SURFACE LOAD (gpm/sf)	PERCENT REMOVAL (%)	EFFLUENT
ADF	Q	150	3.0	-	137
	BOD	20		60	8
	TSS	15	-	75	4
NDF	Q	180	3.5	-	165
	BOD	23	-	57	9
	TSS	20	-	75	4
MDF	Q	231	4.5		214
	BOD	23	-	52	11
	TSS	46	-	75	12
2HP	Q	258	5.0	-	238
	BOD	25	-	56	11
	TSS	55	-	75	14

		EFFLUENT CHARACTERISTIC
ADF	Q	137
	BOD	8
	TSS	4
NDF	Q	165
	BOD	9
	TSS	4
MDF	Q	343
	BOD	23
	TSS	32
2HP	Q	466
	BOD	34
	TSS	47

		DIVERSION CHARACTERISTICS
ADF	Q	0
	BOD	–
	TSS	–
NDF	Q	0
	BOD	–
	TSS	–
MDF	Q	20
	BOD	151
	TSS	160
2HP	Q	75
	BOD	124
	TSS	134

		DIVERSION CHARACTERISTICS
ADF	Q	0
	BOD	-
	TSS	–
NDF	Q	0
	BOD	–
	TSS	–
MDF	Q	129
	BOD	43
	TSS	64
2HP	Q	228
	BOD	58
	TSS	81

DESIGN SLUDGE PRODUCTION		
PRIMARY SLUDGE	122	tpd
ACTIVATED SLUDGE	95	tpd
TOTAL SLUDGE	217	tpd

NOTES

1 ADF - AVERAGE DAILY FLOW
2 NDF - NOMINAL DESIGN FLOW
3 MDF - MAXIMUM DAILY FLOW
4 2HP - 2-HOUR PEAK FLOW RATE
5 Q - FLOW IN MGD
6 BOD - BIOLOGICAL OXYGEN DEMAND IN MG/L
7 TSS - TOTAL SUSPENDED SOLIDS IN MG/L
8 SCFM - STANDARD CUBIC FEET PER MINUTE

FIGURE 4-10. FLOW OF WASTEWATER, TREATMENT CAPACITY, AND EFFLUENT QUALITY OF THE TREATMENT UNITS PROPOSED FOR ALTERNATIVES 1, 2A, AND 2B (SOURCE: ADAPTED FROM CDM et al. 1983).

During development and evaluation of the 15 intermediate alternatives, grit removal prior to primary treatment was identified as a desirable treatment technology, thus the concept of adding grit removal facilities (i.e., aerated grit chambers) ahead of the primary clarifiers was included in all 15 intermediate alternatives. However, during development of final Alternative 1 the City eliminated the concept of grit removal before primary clarification from consideration; thus, grit removal would continue to be practiced using sludge grinders and cyclone type degritters. Maintenance problems and reduced equipment life of primary sedimentation and primary sludge pumping equipment potentially would continue to occur.

While conducting the EIS, odor control was indentified as a key issue. As discussed in Section 4.6 of this EIS, odor control facilities proposed as part of all 15 intermediate alternatives involved:

- Covering and scrubbing exhaust air from all pretreatment, primary, sludge thickening, and sludge dewatering units; and
- Process improvements, including new grit removal facilities, adequate sludge thickening, and improved recycle flow systems.

Initially, the three final alternatives (including Alternative 1) developed by the City and evaluated by the public during CAC meetings and public meetings also contained provisions for covering all major odor-producing treatment facilities and scrubbing all exhaust air. However, the City subsequently decided that odor control by chemical addition may be desirable. The City's draft facilities plan states (CDM et al. 1983):

> "Growth of odor producing anaerobic bacteria can be controlled by constantly maintaining some dissolved oxygen or a positive Oxidation Reduction Potential (ORP) in wastewater while in transit. This can be done by chemical addition or by aeration of wastewater. Pure oxygen addition to a pressurized sidestream has also been used successfully. Some chemicals commonly used to prevent anaerobic conditions include:
>
> - Hydrogen Peroxide (H_2O_2)
> - Potassium Permanganate ($KMnO_4$)
> - Chlorine (Cl_2)
> - Ozone (O_3)
> - Oxygen (O_2)

For Alternative 1, initial odor control would be accomplished by continuously adding chemicals. The draft facilities plan does not specify what chemicals would be added, where chemicals would be added, nor the rate of application. The draft facilities plan also states that, if chemical addition proves unsatisfactory, then additional measures (including covering equipment and scrubbing exhaust air) would be taken to assure maximum control of odors. Additional information on proposed odor control facilities and alternate odor control techniques available is contained in the City's draft facilities plan.

The proposed 137 mgd Village Creek WWTF associated with final Alternative 1 would include energy recovery and utiliziation facilities. Recovered methane gas would be used as fuel for engines that drive blowers to produce air and generate electricity for the facility. Proper management of the methane would significantly reduce dependency on commercial energy sources, provide emergency standby power, produce heat for the anaerobic digesters, and significantly reduce total energy costs. For the expanded Village Creek WWTF, methane gas recovered from anaerobic digesters would be compressed, stored, and used in: (1) the grease and scum incinerator, (2) tri-fuel gas engines, and (3) mixing the contents of the anaerobic digesters. New engines would be needed along with back-up digesters and sludge heating systems. In addition, boilers would be needed to adequately heat the sludge and digesters during very cold periods, and during cool periods if gas production is low. Additional gas storage and compression facilities also would be required for peak energy demand shaving and to allow for downtime. One 50 foot diameter gas storage sphere would be constructed. New piping, scrubbers, and appurtenances also would be required. Insulation on existing and new digester roofs would be provided to decrease energy consumption of the digesters. With these proposed facilities and energy recovery and utilization systems, energy consumption, energy generation, and net energy requirements for Alternative 1 would be as follows (CDM et al. 1982):

Total Energy Required	149.6 x 10^6 kwh/yr
Energy Recovered	67.7 x 10^6 kwh/yr
Net Energy Required	81.9 x 10^6 kwh/yr

Although some maintenance problems and odor problems may periodically occur, the proposed liquid treatment equipment basically would be sound and functional. The anticipated effluent quality which would be produced by the proposed 137 mgd Village Creek WWTF is listed in Table 4-24.

4.7.1.2 Sludge Treatment and Disposal for Alternative 1

Sludge treatment and disposal for Alernative 1 would involve anaerobic digestion of sludge, mechanical dewatering, truck transport to the sludge disposal target area (Site 1) north of Saginaw, and disposal by landspreading on agricultural lands. The existing sludge drying beds located just northeast of the Village Creek WWTF would no longer be used on a daily basis. However, existing sludge pumps, pipes, and valves would remain in place so that the sludge drying beds still could be used under emergency conditions. Truck transport of sludge would be utilized due to right-of-way problems with pipelines (see following paragraphs for additional discussion).

Primary sludge would be withdrawn from the primary clarifiers at approximately 1% solids, and sent through sludge grinders and cyclone degritters. Sludge then would be thickened in gravity thickeners. Four modified and two new gravity thickeners would be utilized. The four existing gravity thickeners would be modified to provide improved chemical feed systems and improved facilities for addition of makeup water. Waste activated sludge would be thickened using both existing sludge centrifuges and new dissolved air flotation units. Thickened primary and secondary sludges then would be blended and sent to ten existing and ten new anaerobic digestors.

Sludge from the anaerobic digestors would be dewatered using mechancial equipment, although the exact type of equipment to be utilized has not yet been specified. Polymer conditioning of sludge followed by dewatering using belt filter presses would produce approximately 622 tons per day (tpd) of 25 percent solids sludge to be hauled. Lime and/or ferric chloride conditioning of sludge followed by dewatering via plate and frame presses would produce approximately 385 tpd of 50 percent solids sludge to be hauled. Because lime treated sludge is alkaline and thus not extremely useful as a soil conditioner when applied to alkaline soils, belt press dewatering potentially would be

TABLE 4-24. ESTIMATED TREATED EFFLUENT CHARACTERISTICS FOR ALTERNATIVES 1, 2A, AND 2B

Parameter	Unit	Value for Average Daily Flow
Flow: 1985	MGD	96
2005	MGD	137
BOD	mg/l	8
TSS	mg/l	4
NH_3-N	mg/l	20
Total Solids	mg/l	750
Total Settleable Solids	ml/l	1
COD	mg/l	20
Total Phosphate	mg/l	5
Ortho-Phosphate	mg/l	4
pH	-	7
Metals		
Al	mg/l	2.50
Cd	mg/l	0.03
Cr	mg/l	0.02
Cu	mg/l	0.03
Fe	mg/l	0.17
Mn	mg/l	0.01
Ni	mg/l	0.06
Pb	mg/l	0.04
Zn	mg/l	0.06

SOURCE: ADAPTED FROM CDM et al. 1983.

used with Alternative 1. All mechanical dewatering equipment would be located at the Village Creek WWTF.

During development of the 15 intermediate alternatives, transport of liquid sludge through pipelines was found to be the most cost-effective transport method. However, it was recognized that pipe transport lacked flexibility, requiring a new pipeline to be built if an alternate delivery point is desired. Also, there would be many right-of-way problems with installation of a pipeline. Since the exact location of the proposed sludge stockpile north of Saginaw was not specified in the draft facilities plan, the City determined truck hauling of sludge to be most desirable. Dewatered sludge would be hauled in 30 cubic yard (cy) trucks, similar to 18-wheel gravel trucks common to the area. Approximately 30 to 35 truck trips per day would be required to haul dewatered sludge to the area north of Saginaw (Site 1). Trucks would travel from the Village Creek WWTF via a plant access road to the Arlington-Bedford road, thence to SH 183, thence to IH 820, thence to IH 35W, and thence to US 81 into the target sludge application zone north of Saginaw (refer to Figure 4-7). Since the exact location of a proposed sludge storage pile and sludge application site within the sludge disposal target zone was not specified by the City, the exact routes sludge haul trucks would take once in the sludge disposal target zone cannot be specified.

Development of concepts of sludge disposal in the target zone north of Saginaw (Site 1) were predicated on the assumption that the City of Fort Worth would have a new municipal refuse landfill located in the target zone. Understanding this assumption is critical to understanding the environmental evaluation of alternatives as presented in Chapter 5.0 of this EIS. Since it is assumed that a municipal refuse landfill would be in place and operating in the target area north of Saginaw (Site 1), environmental effects caused by constructing and operating a municipal refuse landfill are not addressed because it is assumed that those effects already would have occurred. At the time Alternative 1 was developed, the City of Fort Worth Sanitation Department was actively looking for an acceptable municipal refuse landfill site in the target area (Site 1). However, as of 1 January 1983 an acceptable municipal refuse landfill site had not been located.

For Alternative 1, sludge would be stockpiled within a 175-acre stockpile area adjacent to the municipal refuse landfill. Sludge would be placed on an asphalt pad approximately 30 acres in size. Rainwater runoff and leachate (if any) from the sludge would drain to an evaporation pond located at the corner of the asphalt pad. One or more groundwater monitoring wells would be provided to detect any migration of leachate into the ground. The area covered by the storage pad plus access roads, equipment storage facilities, maintenance shops and other operational facilities would total approximately 60 acres, with the remainder of the 175 acres left as an undisturbed buffer zone. During storage, sludge would dry from 25 to approximately 40 or 50 percent solids. The asphalt pad would be large enough to store all sludge produced by the expanded Village Creek WWTF (i.e., 154 tons of dry sludge per day) for several years.

Ultimate sludge disposal would be by landspreading, or placement of dried sludge on top of the ground. Sludge then is typically disked into the ground by the landowner to act as a soil conditioner and/or fertilizer. Table 4-25 is a comparison of typical fertilizer applications and application of one to three tons per year of Fort Worth's sludge to soil. Information on chemical characteristics of Fort Worth's sludge as determined by laboratory analyses is given in Appendix B of this EIS. Sludge would not be disposed on City owned land, but would be distributed on a give-away basis to farmers and landowners north of Saginaw. Equipment for loading sludge from the stockpile would be owned and operated by the City. The City also would potentially maintain a limited amount of sludge hauling and distribution equipment at the stockpile site, so that sludge could be spread on agricultural lands where landowners did not own proper spreading equipment.

Disposal of sludge on land is governed by regulations described in 40 CFR 257. Criteria limiting application of cadmium and polychlorinated biphenyls (PCB's) on land where food-chain crops are grown are given in sections 257.3-5 (a) and 257.3-5(b), respectively. Basically, for soils similar to those at Site 1, cadmium application would be limited to 0.45 lbs/acre per year with a maximum lifetime application of 17.8 lbs/acre. Application of PCB's requires sludge to be incorporated into the soil if the PCB level is greater than 10 mg/kg dry weight. According to laboratory tests, PCBs in Fort Worth's sludge

TABLE 4-25. COMPARISON OF COMMERCIAL FERTILIZER APPLICATION RATES AND WASTEWATER SLUDGE APPLICATION RATES

Crop	Commercial Fertilizer Data Fertilizer* Analysis	Fertilizer Application Rate (lbs./acre)	Resulting Nitrogen Loading (lbs./acre)	Fort Worth Sludge Data ** Sludge Application Rate (dry tons/acre	Resulting Nitrogen Loading (lb/acre)
Grain Sorghum & Sudan Grass	60-40-0	200	120	2-3	120
Wheat & Oats	28-14-0 & 34- 0-9	200 175	56 60	2-3	116
Bermuda Grass & Native Grass	34-0-0	200	68	1-2	68

* The fertilizer information is general information based on area farmers' usages; figures will vary. The analysis is for Nitrogen (NH_4), Phosphorous (P_2O_5), and Potassium (K_2O) in that order. The numbers are percentages of the nutrient per 100 lbs of fertilizer.

** The sludge application rate assumes that the sludge (5-10% solids) has 53 pounds of available nitrogen per dry ton of sludge.

SOURCE: CDM et al. 1983.

equal 3.3 mg/kg; thus the PCB limitations are not of concern. Guidelines for application of other heavy metals are given in a document entitled "Application of Sludges and Wastewaters on Agricultural Land" (Knezek et al. 1978). Table 4-26 indicates the allowable lifetime application of heavy metals according to these regulations and guidelines, compared with the amount of heavy metals in Fort Worth's sludge which would be applied to land over the twenty-year planning period (i.e., 1985-2005).

For Alternative 1, sludge would be applied to croplands at the rate of 2.6 tons/acre. At this rate, lifetime applications of heavy metals would be well within requirements. Application of sludge to grasslands would be at the maximum rate of 5.0 tons/acre. Again, all heavy metal applications would be within requirements except cadmium; however, cadmium requirements are only applicable to food-chain crops, and grasslands are not food crops. If lifetime applications exceed 17.8 lbs/acre of cadmium, then when land is sold it should contain a statement in the deed that soils should be analyzed before food-chain crops are grown. Farmers obtaining sludge at the stockpile site would be given copies of the regulations and required to sign a release stating that proper application procedures and rates would be complied with.

The sludge disposal regulations (40 CFR 257) address disease vectors associated with sludge. Prior to surface application, sludge must be treated by a process to significantly reduce pathogens (PSRP). Anaerobic digestion is one PSRP process, so sludge currently is and would with the expanded WWTF be treated to PSRP. Sludge application to land also must meet one of the following:

- If sludge is applied to food chain crops or if food chain crops or grown within 18 months following application, then the sludge must be treated by a "process to further reduce pathogens" (PFRP). In other words, it must be disinfected. Acceptable systems for PFRP include composting, heat drying, heat treatment, thermophillic aerobic digestion, and PSRP processes followed by pasteurization or irradiation;
- Public access must be controlled for 12 months, and grazing by animals whose products are consumed by humans must be prevented for 30 days following application; and
- If sludge is applied where public access cannot be controlled (i.e., on City parks, golf courses, and other public lands) then disinfection (or PFRP) must be provided.

TABLE 4-26. COMPARISON OF ALLOWABLE TOTAL HEAVY METALS APPLICATION TO FOOD-CHAIN CROPS AND AMOUNTS TO BE ADDED BY APPLICATION OF FORT WORTH SLUDGE AT RATES OF 2.6 TONS/ACRE AND 5.0 TONS/ACRE

Parameter	Allowable Application (lbs/Acre)	Actual Application At 2.6 Tons/Acre For 20 Years (lbs/Acre)	Actual Application At 5.0 Tons/Acre for 20 Years (lbs/Acre)
Cadmium	17.8	9.4	18.1
Lead	2000	27.0	51.9
Zinc	1000	170.0	326.9
Copper	500	43.0	82.7

SOURCE: ADAPTED FROM CDM et al. 1983.

For Alternative 1, sludge disinfection would not be required because sludge would be applied to private agricultural lands and not public lands. Landowners would be required to comply with regulations regarding control of public access and grazing by animals. As previously stated, landowners also would be required to apply sludge at or below the prescribed rates. At the prescribed application rates, sludge would be placed on approximately 22,000 acres of land per year.

In summary, Alternative 1 would involve expansion of the Village Creek WWTF to treat 137 mgd at its present site (Site 2), with disposal of sludge by landspreading on 22,000 acres somewhere within a 60,000-acre sludge disposal target area north of Saginaw (Site 1). Major components of Alternative 1 would include:

- New sewage collection lines (see Section 4.4.1);
- A new TRA transfer pipeline (see Section 4.3.5);
- New preliminary and primary treatment units;
- New secondary treatment (activated sludge) units;
- New Advanced treatment (dual media filtration) units;
- New effluent disinfection (chlorination) units;
- New sludge thickening and anaerobic digestion units;
- New energy recovery (methane gas) and utilization facilities;
- New mechanical dewatering (belt press) units;
- Odor control by chemical addition or other effective method at the Village Creek WWTF;
- Trucking dewatered sludge to a 175-acre stockpile area north of Saginaw; and
- Ultimate sludge disposal by surface landspreading 2.6 tons per acre per year on 22,000 acres of agricultural farmland and grassland.

Estimated costs of capital improvements (both grant eligible and ineligible), operation and maintenance costs, and salvage values remaining after a 20-year planning period for the components of Alternative 1 are listed in Table 4-27.

TABLE 4-27. ESTIMATED COSTS BY COMPONENT FOR ALTERNATIVE 1 FOR THE FORT WORTH SYSTEM (IN MILLIONS OF DOLLARS)

	Construction Cost	Capital Cost	Annual O&M Cost 1985	Annual O&M Cost 2005	Salvage Value
Preliminary Treatment	1.24	1.62	0.55	0.78	0.21
Primary Treatment	2.86	3.75	0.44	0.63	0.48
Pump to Secondary Treatment	1.01	1.32	0.40	0.57	0.17
Secondary Treatment	26.78	35.08	1.88	2.68	4.47
Filtration	17.45	22.86	0.98	1.40	2.91
Chlorination	4.33	5.67	0.38	0.54	0.72
Misc. Piping (Sludge)	0.46	0.60	0.00	0.00	0.23
Flotation Thickening	2.10	2.75	0.30	0.43	0.35
Gravity Thickening	0.00	0.00	0.03	0.04	0.00
Energy Recovery Unit	1.40	1.83	0.37	0.53	0.23
Anaerobic Digestion	7.99	10.47	0.62	0.88	1.33
Pump to Dewatering Equipment	0.05	0.07	0.08	0.11	0.01
Sludge Conditioning	0.49	0.64	0.90	1.28	0.08
Sludge Dewatering	8.41	11.02	0.78	1.11	1.40
Truck to Land Spreading Site	0.55	0.72	0.48	0.69	0.00
175 Acres of Land (Stockpile & Buffer)	0.35	0.46	0.00	0.00	0.63
Stockpiling	2.87	3.76	0.01	0.01	0.48
Land Spreading of Sludge	7.62	9.98	0.66	0.94	1.27
Odor Control	6.26	8.20	0.04	0.06	1.05
Maintenance Facility	1.50	1.97	1.04	1.48	0.25
Sewer Interceptors	43.52	57.01	0.96	1.37	21.76
SUBTOTAL	137.24	179.78	10.90	15.53	38.03
Less Credit for Power and Heating	0.00	0.00	1.61	2.30	0.00
TOTAL	137.24	179.78	9.29	13.23	38.03

SOURCE: CDM 1983c.

4.7.2 Description of Alternative 2A

Alternative 2A (referred to in the draft facilities plan as Alternative 2) is the second final alternative evaluated by the City. Alternative 2A would involve expansion of the Village Creek WWTF (Site 2) to a capacity of 137 mgd. Sludge generated at the WWTF would be mechanically dewatered at the WWTF and transported by truck to a sludge disposal target area north of Saginaw (Site 1) for disposal in a municipal refuse landfill (Figure 4-11). The sludge disposal target area north of Saginaw (Site 1) is the same area as discussed for Alternative 1. The proposed truck route also is identical to that discussed for Alternative 1.

4.7.2.1 Liquid Treatment for Alternative 2A

Liquid treatment for Alternative 2A would consist of expanding the Village Creek WWTF (Site 2) to a 137 mgd capacity, exactly as for Alternative 1. Therefore, all units for coarse screening, primary sedimentation, activated sludge secondary treatment, dual media filtration advanced treatment, effluent disinfection by chlorination, effluent discharge to the Trinity River, odor control, and energy (methane gas) recovery and utilization would be identical to those described for Alternative 1 (refer to Section 4.7.1.1 of this EIS). Net energy required (i.e., total energy required less energy recovered) for the expanded WWTF in Alternative 2A also would be identical to that required for Alternative 1. Anticipated effluent quality for Alternative 2A would be the same as for Alternative 1 (refer to Table 4-24).

4.7.2.2 Sludge Treatment and Disposal for Alternative 2A

Sludge treatment and disposal for Alternative 2A would involve thickening, anaerobic digestion, mechanical dewatering, truck transport to the sludge disposal target area north of Sagninaw (Site 1), and disposal by co-disposal landfilling in a municipal refuse landfill. The existing sludge drying beds at the Village Creek WWTF would be abandoned, but retained for future emergency use.

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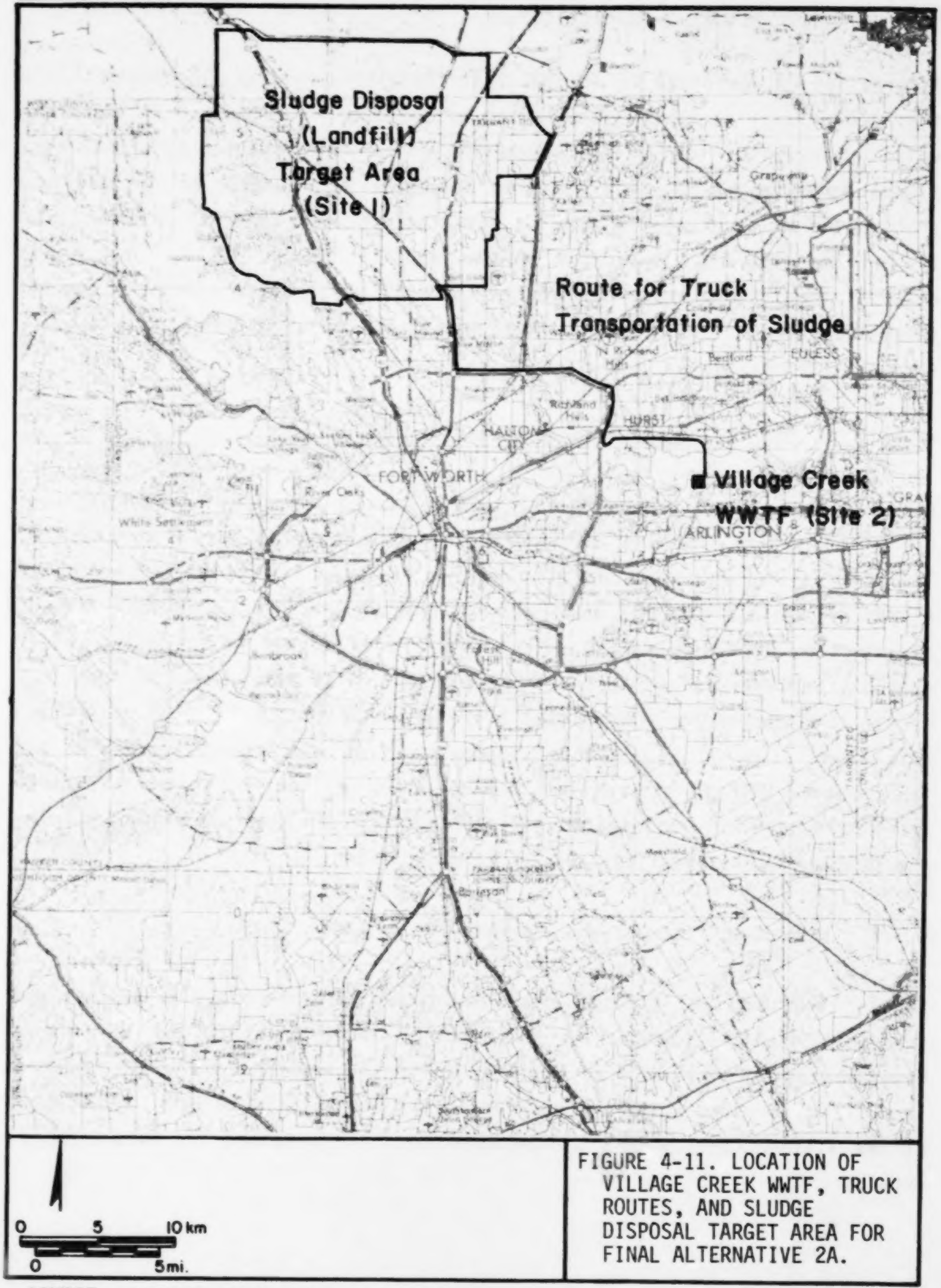

FIGURE 4-11. LOCATION OF VILLAGE CREEK WWTF, TRUCK ROUTES, AND SLUDGE DISPOSAL TARGET AREA FOR FINAL ALTERNATIVE 2A.

SOURCE: ADAPTED FROM CDM et al. 1982.

All sludge treatment provided at the expanded Village Creek WWTF, with the exception of mechanical dewatering, would be identical to that described for Alternative 1 (refer to Section 4.7.1.2). For Alternative 2A, mechanical dewatering would involve conditioning sludge with lime and/or ferric chloride and dewatering with plate and frame presses to produce approximately 385 tpd of sludge at 50 percent solids. Alkalinity of lime treated sludge is not a deterrent to Alternative 2A since sludge would be landfilled.

Dewatered sludge would be hauled in 30 cy trucks. Approximately 20 to 25 truck trips per day would be required to haul dewatered sludge to the sludge disposal target area north of Saginaw (Site 1). The route taken by haul trucks would be identical to that described for Alternative 1.

As was the case for Alternative 1, Alternative 2A was developed with the assumption that the City of Fort Worth would have a new municipal refuse landfill located in the sludge disposal target zone. A new landfill would be needed because Fort Worth's existing landfill(s) potentially would be at capacity in two to five years (Davis 1983). However, as of 1 January 1983 the City had not selected a new landfill site in the target area.

Sludge would be stockpiled on an asphalt pad located in a 40-acre working area, similar to the 60-acre working area described for Alternative 1. Rainwater and leachate control systems, an evaporation pond, and a monitoring well system would be identical to Alternative 1. A similar 175-acre total site probably would be purchased to provide buffer areas around the stockpile. Approximately 385 tpd of sludge would be disposed by mixing it with up to an estimated 1,960 tons of municipal refuse which would be generated in the planning area. The exact amount of municipal refuse which would be disposed at a landfill in the target zone currently is not known. Stabilized, dewatered sludge would be adequate for use as a daily cover at the co-disposal landfill site. Additional surface water, leachate, groundwater protection, odor, and disease vector control systems would not be required at the co-disposal landfill, because all necessary landfill operation and control systems would already be in place at the existing municipal refuse landfill site.

In summary, Alternative 2A would involve expansion of the Village Creek WWTF to treat 137 mgd at its present site (Site 2), with disposal of sludge by landfilling in a co-disposal municipal refuse landfill located in a 60,000 acre sludge disposal target zone north of Saginaw (Site 1). Major components of Alternative 2A would include:

- New sewage collection lines (see Section 4.4.1);
- A new TRA transfer pipeline (see Section 4.3.5);
- New preliminary and primary treatment units;
- New secondary treatment (activated sludge) units;
- New advanced treatment (dual media filtration) units;
- New effluent disinfection (chlorination) units;
- New sludge thickening and anaerobic digestion units;
- New energy recovery (methane gas) and utilization facilities;
- New mechanical dewatering (plate and frame filter press) units;
- Odor control by chemical addition or other effective method at Village Creek WWTF;
- Trucking dewatered sludge to a 175-acre stockpile area north of Saginaw; and
- Ultimate sludge disposal by landfilling 385 tons/year by co-disposal in an existing municipal refuse landfill.

Estimated costs of capital improvements (both grant eligible and ineligble), operation and maintenance costs, and salvage values remaining after a 20-year planning period for components of Alternative 2A are listed in Table 4-28.

4.7.3 Description of Alternative 2B

When Alternative 2A first was developed and evaluated by the City, it was met with some favor. However, at public meetings citizens raised a concern over what exactly would be done in the sludge disposal target zone north of Saginaw. Most of the concern centered around the fact that the exact location of the proposed stockpile and landfill in the target area could not be speci-

TABLE 4-28. ESTIMATED COSTS BY COMPONENT FOR ALTERNATIVE 2A FOR THE FORT WORTH SYSTEM (IN MILLIONS OF DOLLARS)*

	Construction Cost	Capital Cost	Annual O&M Cost		Salvage Value
			1985	2005	
Preliminary Treatment	1.24	1.62	0.55	0.78	0.21
Primary Treatment	2.86	3.75	0.44	0.63	0.48
Pump to Secondary Treatment	1.01	1.32	0.40	0.57	0.17
Secondary Treatment	26.78	35.08	1.88	2.68	4.47
Filtration	17.45	22.86	0.98	1.40	2.91
Chlorination	4.33	5.67	0.38	0.54	0.72
Misc. Piping (Sludge)	0.46	0.60	0.00	0.00	0.23
Flotation Thickening	2.10	2.75	0.30	0.43	0.35
Gravity Thickening	0.00	0.00	0.03	0.04	0.00
Energy Recovery Unit	1.40	1.83	0.37	0.53	0.23
Anaerobic Digestion	7.99	10.47	0.62	0.88	1.33
Pump to Dewatering Equipment	0.05	0.07	0.04	0.06	0.01
Sludge Conditioning	0.84	1.10	0.91	1.30	0.14
Sludge Dewatering	14.21	18.62	0.62	0.88	2.37
Truck to Land Spreading Site	0.36	0.47	0.53	0.76	0.00
175 Acres of Land (Stockpile & Buffer)	0.82	1.07	0.00	0.00	1.48
Stockpiling	1.13	1.48	0.01	0.01	0.19
Land Spreading of Sludge	4.66	6.10	0.17	0.24	0.78
Odor Control	6.26	8.20	0.04	0.06	1.04
Administrative and Maintenance	1.50	1.97	1.04	1.48	0.25
Sewer Interceptors	43.52	57.01	0.96	1.37	21.76
SUBTOTAL	138.97	182.04	10.27	14.64	39.12
Less Credit for Power and Heating	0.00	0.00	1.61	2.30	0.00
TOTAL	138.97	182.04	8.66	12.34	39.12

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*Alternative 2A is equivalent to Alternative 2 in the draft facilities plan.

SOURCE: CDM 1983c.

fied by the City; therefore, citizens living north of Saginaw all assumed that new facilities would be built directly adjacent to their homes. The Fort Worth City Council, in response to citizen's concerns, instructed the City staff to pursue the concept of expanding the Village Creek WWTF and disposing of sludge in a landfill, but with a new landfill location. In response to the City Council's request, the staff developed an additional alternative referred to in the Draft EIS as Alternative 2B.

Alternative 2B would involve expansion of the Village Creek WWTF at its present site (Site 2) to a capacity of 137 mgd. Sludge generated at the WWTF would be pumped in liquid form to a 500-acre site just across the Trinity River (i.e., north of the existing WWTF), mechanically dewatered at the site (Site 2), and disposed of by landfilling only sludge in a new landfill. Figure 4-12 illustrates the proximity of the landfill to the existing Village Creek WWTF. Figure 4-13 is a detailed map of the Village Creek WWTF, the proposed sludge pipeline route, and the proposed landfill site. The proposed sludge pipeline crossing the Trinity River will be constructed underneath the river.

4.7.3.1 Liquid Treatment for Alternative 2B

Liquid treatment for Alternative 2B would consist of expanding the Village Creek WWTF (Site 2) to treat 137 mgd of wastewater, exactly as proposed for Alternative 1. Therefore, all units for coarse screening, primary sedimentation, activated sludge secondary treatment, dual media filtration advanced treatment, effluent disinfection by chlorination, effluent discharge to the Trinity River, odor control, and energy (methane) recovery and utilization would be identical to those described for Alternative 1 (refer to Section 4.7.1.1). Energy requirements versus energy recovered for Alternative 2B would be (CDM et al. 1983):

Total Energy Required	149.6 x 10^6 kwh/yr
Energy Recovered (up to)	46.8 x 10^6 kwh/yr
Net Energy Required	102.8 x 10^6 kwh/yr

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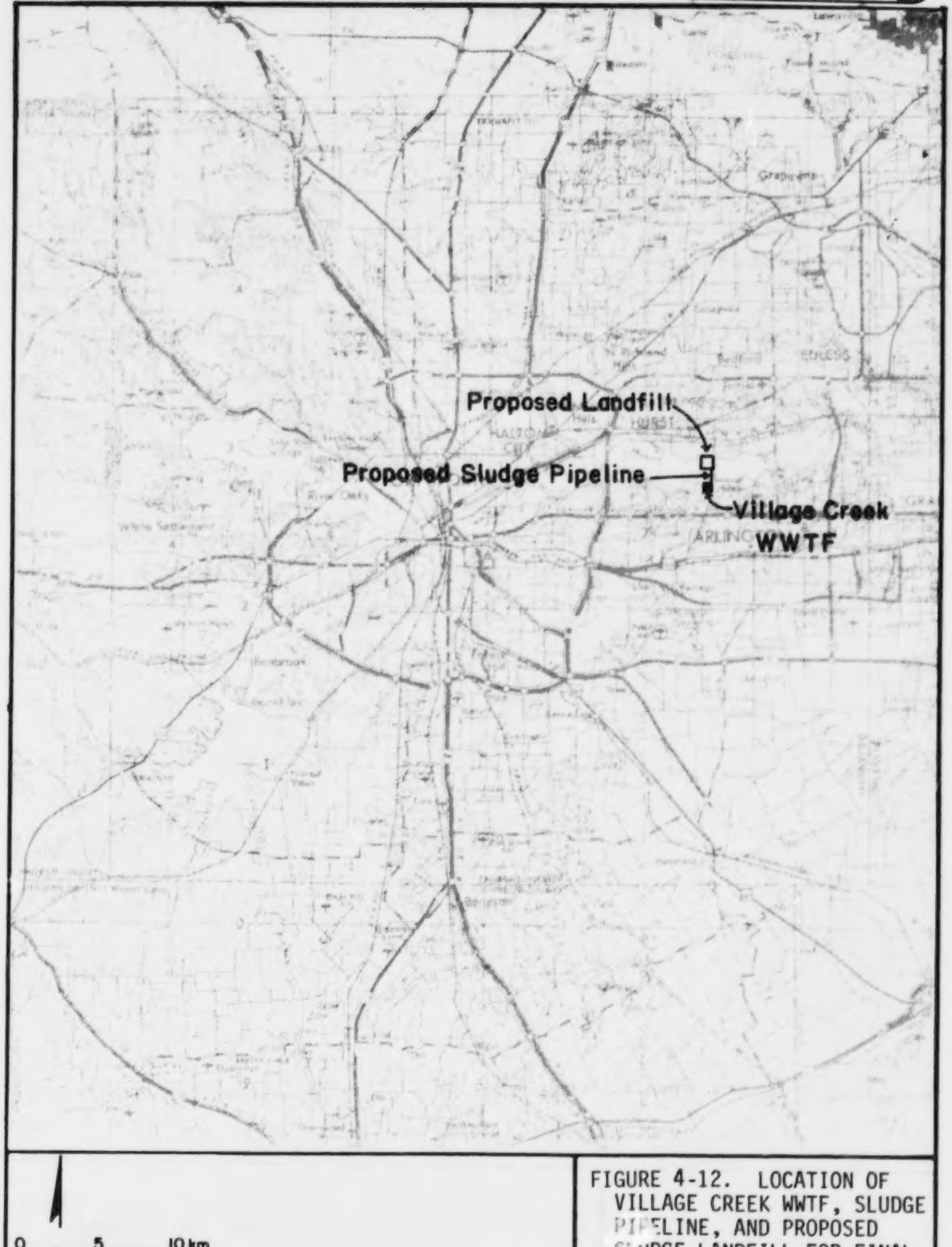


FIGURE 4-12. LOCATION OF VILLAGE CREEK WWTF, SLUDGE PIPELINE, AND PROPOSED SLUDGE LANDFILL FOR FINAL ALTERNATIVE 2B.

SOURCE: ADAPTED FROM CDM et al. 1982.

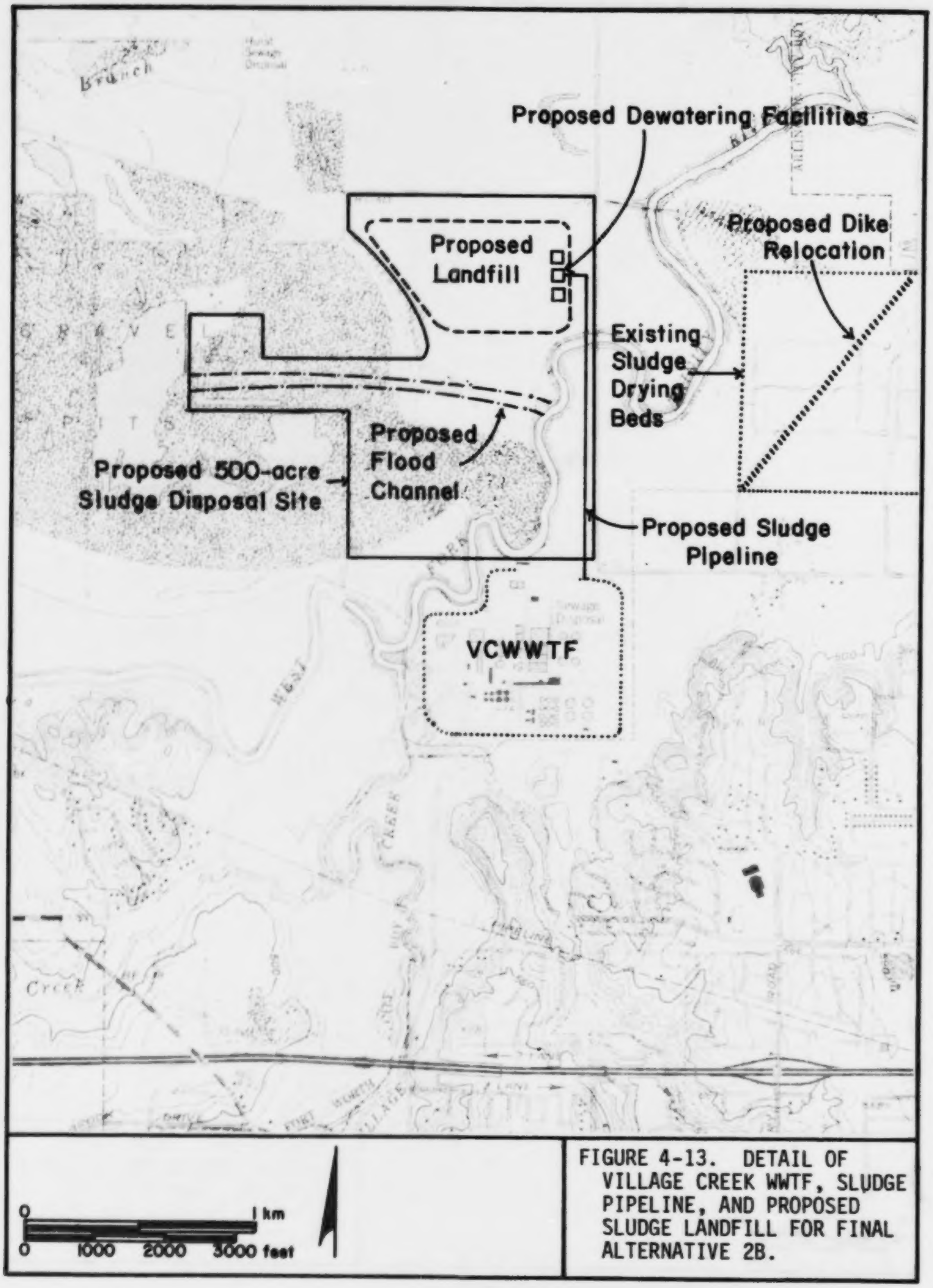


FIGURE 4-13. DETAIL OF VILLAGE CREEK WWTF, SLUDGE PIPELINE, AND PROPOSED SLUDGE LANDFILL FOR FINAL ALTERNATIVE 2B.

Anticipated effluent quality for Alternative 2B would be the same as for Alternative 1 (refer to Table 4-24).

4.7.3.2 Sludge Treatment and Disposal for Alternative 2B

Sludge treatment and disposal for Alternative 2B would involve thickening, anaerobic digestion, transport via pipeline to the adjacent landfill site, mechanical dewatering, and ultimate disposal by landfilling or beneficial reuse.

All sludge treatment provided at the Village Creek WWTF, with the exception of mechanical dewatering, would be identical to that described for Alternative 1 (refer to Section 4.7.1.2). For Alternative 2B, sludge would be drawn from anaerobic digestors and pumped through a pipeline approximately 8,000 feet long to the landfill site. For safety, backup, and routine maintenance reasons two 12-inch diameter pipelines would be used. Polymer conditioning followed by mechanical dewatering would be accomplished at the landfill site using belt filter presses to produce a sludge cake at approximately 25 percent solids. Sludge then would be stockpiled for disposal. The proposed sludge pipeline crossing the Trinity River will be constructed underneath the Trinity River.

Initially, sludge at 25 to 60 percent solids content would be disposed of in a sludge-only landfill. Sludge taken directly from the belt presses would be at approximately 25 percent solids, thus a total of 622 tpd of material would be stockpiled. Material air-dried in the stockpile would be at 50-60 percent solids content, thus a total of 260-310 tpd would be disposed. Because of the advantageous volume reduction gained by drying, the City probably would dispose of stockpiled sludge when possible. However, if odor or operational problems developed with the stockpile facilities, then the practice of landfilling sludge directly from the belt presses would be initiated.

The landfill would be designed using one of four methods (Figure 4-14). Method 1 would involve building a deep landfill (approximately 55 feet deep) with the bottom reaching an existing, dense layer of shale. The shale would be scarified and compacted to form an impermeable layer at the bottom of the

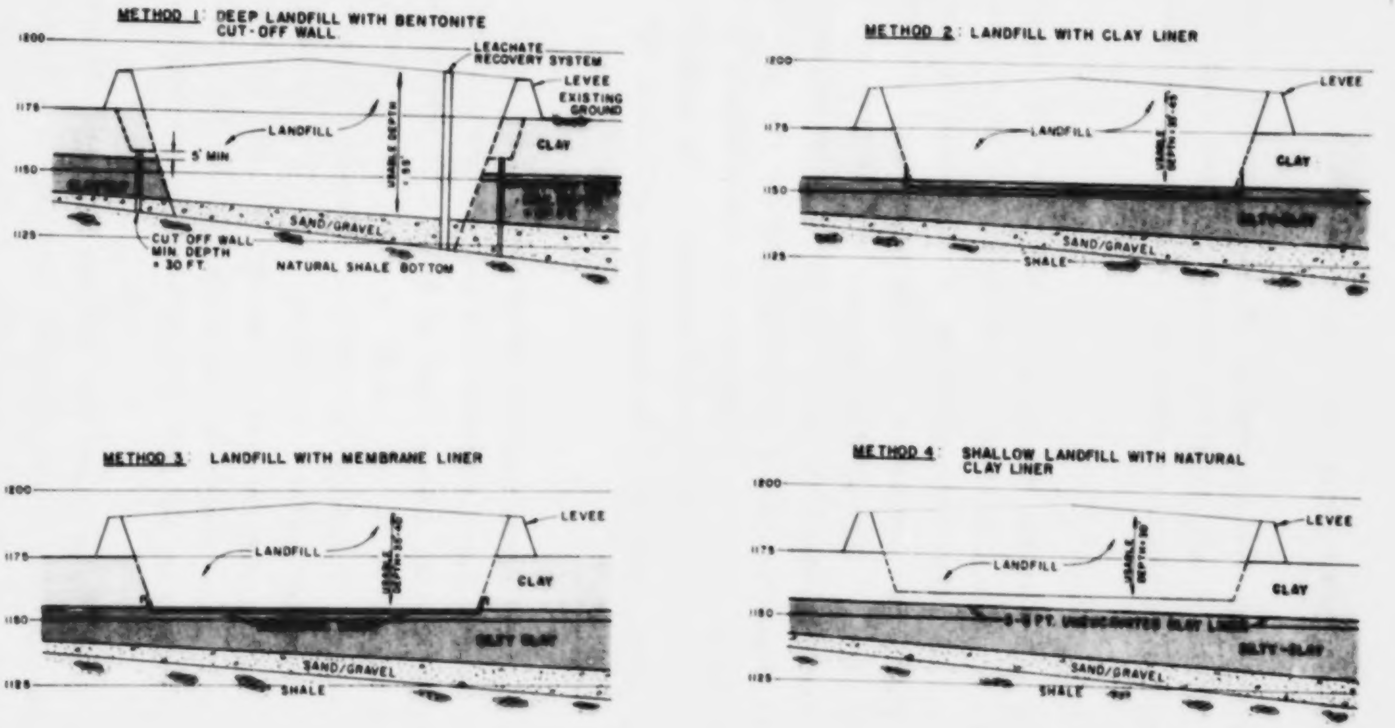


FIGURE 4-14. SLUDGE LANDFILLING METHODS AVAILABLE FOR UTILIZATION IN ALTERNATIVE 2B (SOURCE: CDM et al. 1983).

landfill. A dike or levee would be built around the landfill to protect the landfill site, including the mechanical dewatering area, from flooding. The height of the proposed levee is not specified in the facilities plan. A clay (bentonite) or bentonite/cement cut-off wall keyed into the shale layer would be constructed around the landfill. The impermeable bottom and cut-off wall would prevent any leachate from the landfill from escaping. A leachate collection system would return all contaminated liquids from the landfill back to the Village Creek WWTF for treatment. Sludge would be landfilled in three foot to five foot lifts, with one-half to two foot thick layers of soil placed daily over the sludge. The final ratio of soil to sludge would be about 1:1 by volume (CDM et al. 1983). Method 1 would require approximately 92 acres of land for the landfill and surrounding dikes.

Method 2 and 3 would involve constructing a landfill of moderate depth, approximately 35 to 45 feet or 35 feet to 40 feet, respectively. To form an impermeable layer, Method 2 would utilize approximately 3 feet of compacted natural clays on bottom, while Method 3 would utilize a synthetic membrane liner. Both landfills would contain dikes and leachate collection systems identical to Method 1. Method 2 would require approximately 120 to 160 acres of land, while Method 3 would require approximately 160 acres.

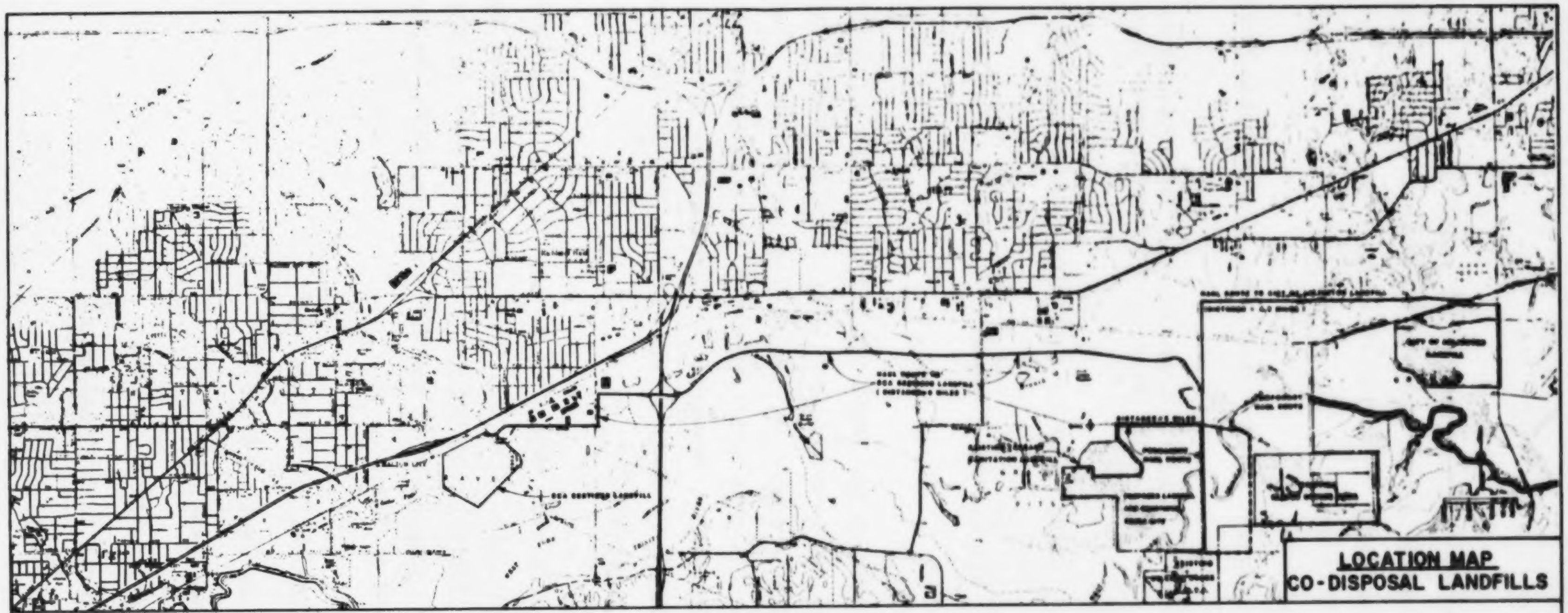
Method 4 would involve a shallow landfill (approximately 30 feet deep) built in existing clay soils. The bottom layer would consist of a 5 foot thick impermeable layer of naturally occurring clay. Method 4 also would involve construction of a levee and a leachate collection and treatment system identical to Method 1, and would require approximately 185 acres of land.

Exactly which of these landfill methods would be built currently is not known. However, it is known that the proposed landfill would be built within the Trinity River floodway. By definition, construction within a floodway would cause a restriction in the available area floodwaters normally pass through, potentially raising flood elevations upstream. To prevent this, the City would construct a flood relief channel adjacent to the landfill, and would relocate one levee surrounding the existing sludge drying beds in order to create an additional path or area through which floodwaters would flow unrestricted (refer to Figure 4-13). Also, the existing gravel pit spoil piles south of the relief channel will be levelled to below 470 feet elevation.

The flood relief channel would have an 800 foot bottom width, with 5:1 side slopes and a total length of approximately 6,100 feet. During a 100-year frequency flood, the water surface elevation in the Trinity River would be as much as 0.4 feet lower than the water surface elevation under existing conditions. It is therefore possible to construct the landfill within the floodway without adversely affecting flooding, as long as additional channel improvements (such as the proposed channelization and relocation of levees) also are made. Design details of the flood relief channel would be provided to the US Army Corps of Engineers if a Section 404 or Section 10 permit application is required.

Upstream from the landfill, due to Alternative 2B, velocities in the Trinity River will increase from existing conditions by ±0.3 feet per second (fps) in the river channel and ±0.1 fps in the overbank area. Adjacent to the landfill, the maximum velocity increase in the main channel would be from 2.7 fps to 4.3 fps; the left overbank velocity would increase from 1.1 to 1.5 fps, and the right overbank velocity would increase from 0.7 fps to 1.0 fps. In the transition section - from the landfill to the sludge drying beds - velocities are identical under both conditions (2.2 fps). Adjacent to the sludge drying beds velocities would drop from 4.6 fps to 3.5 fps, and downstream from the sludge drying beds flood velocities under existing conditions and those occurring after implementation of Alternative 2B would be identical. The maximum velocity anywhere under current flood conditions is 5.8 fps and is in the main channel. After construction of Alternative 2B the maximum velocity anywhere would be 5.2 fps (CDM 1983a).

The major sludge disposal technique for Alternative 2B, and the system for which Federal construction grant monies would be requested, would involve landfilling in a sludge only landfill built just north of the existing Village Creek WWTF. However, other disposal and beneficial reuse programs also would be included in Alternative 2B. As backup to the proposed sludge only landfill, the City's draft facilities plan proposes co-disposal in some or all of several nearby municipal refuse landfills (Figure 4-15). The City's ultimate



SITE LIFE AND HAUL DISTANCE COMPARISON

SITE	DISTANCE VILLAGE CREEK PLANT TO SITE	SITE LIFE
SCA SERVICES	9 MILES	11 YEARS (CURRENT SPACE)
TARRANT SANITATION	2 MILES	9 YEARS (EST)
VILLAGE CREEK LANDFILL	1 MILE	20 YEARS
CITY OF ARLINGTON LANDFILL	4.5 MILES	20 YEARS
CITY OF FORT WORTH LANDFILL (SE)	15.0 MILES	2 YEARS (EST)

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FIGURE 4-15. LOCATION OF CO-DISPOSAL LANDFILLS PROPOSED AS BACK-UP TO ALTERNATIVE 2B (SOURCE: CDM et al. 1983).

goal, however, is to develop a program for beneficial reuse of sludge. To accomplish this goal, the City would assign one staff member to oversee the process to plan, design, and implement a beneficial reuse program(s). Concepts which have been suggested include:

- Agricultural application of liquid sludge, dewatered sludge, and dried sludge;
- Composting (sludge disinfection by PFRP) followed by bag marketing, give-away programs, use as a soil conditioner in landscaping, and use on highway medians, parks, and other public lands;
- Reclaiming strip mine areas using liquid, dewatered and/or composted sludge; and
- Other experimental programs within the framework of local, state, and Federal agencies.

These concepts are discussed further in the draft facilities plan as a realistic and achievable long-term goal. By reaching this goal, the City ultimately would beneficially use all sludge produced at the Village Creek WWTF. Any beneficial reuse program will be designed and implemented in accordance with all applicable regulatory requirements. However, for purposes of this EIS, landfilling of sludge in a sludge only landfill adjacent to the WWTF is the disposal method proposed for Alternative 2B.

In summary, Alternative 2B would involve expansion of the Village Creek WWTF to treat 137 mgd at its present site (Site 2), with disposal of sludge by landfilling in a sludge only landfill located on a 500-acre site in the Trinity River floodplain (Site 2) just north of the Village Creek WWTF. Major components of Alternative 2B would include:

- New sewage collection lines (see Section 4.4.1);
- A new TRA transfer pipeline (see Section 4.3.5);
- New preliminary and primary treatment units;
- New secondary treatment (activated sludge) units;
- New advanced treatment (dual media filtration) units;
- New effluent disinfection (chlorination) units;

- New sludge thickening and anaerobic digestion units;
- New energy recovery (methane gas) and utilization facilities;
- Odor control by chemical addition or other effective method at the Village Creek WWTF;
- Pumping liquid sludge to a 500 acre landfill area north of the Village Creek WWTF;
- Mechanical dewatering (belt press) at the landfill site;
- Disposal of sludge in a sludge only landfill;
- Construction of a floodwater channel(s) and relocation of the dike(s) around the existing sludge drying beds to prevent raising flood levels upstream; and
- Future beneficial reuse of sludge.

Estimated costs of capital improvements (both eligible and ineligible), operation and maintenance costs, and salvage values remaining after a 20-year planning period for the components of Alternative 2B are listed in Table 4-29.

4.7.4 Description of Alternative 3

Alternative 3 would involve upgrading the Village Creek WWTF at its present location (Site 2) to maintain adequate treatment of 96 mgd under various flow conditions, with treatment and disposal of sludge generated at the WWTF by landspreading on agricultural lands north of Saginaw (Site 1). An additional 41 mgd of sewage would be treated by slow rate irrigation on approximately 8,460 acres of agricultural land in northwest Johnson County just northeast of Godley TX (Site 3). A small amount of sludge generated at the land treatment site (Figure 4-16) also would be disposed by landspreading on the irrigated lands.

4.7.4.1 Liquid Treatment for Alternative 3 (Village Creek WWTF)

Liquid treatment for Alternative 3 would involve two separate systems using two separate treatment technologies. The first liquid treatment system would involve upgrading the Village Creek WWTF to adequately treat an average 96 mgd of wastewater with equipment to properly handle the flow variations currently

TABLE 4-29. ESTIMATED COSTS BY COMPONENT FOR ALTERNATIVE 2B FOR THE FORT WORTH SYSTEM (IN MILLIONS OF DOLLARS)*

	Construction Cost	Capital Cost	Annual O&M Cost 1985	Annual O&M Cost 2005	Salvage Value
Preliminary Treatment	1.24	1.62	0.55	0.78	0.21
Primary Treatment	2.86	3.75	0.44	0.63	0.48
Pump to Secondary Treatment	1.01	1.32	0.40	0.57	0.17
Secondary Treatment	26.78	35.08	1.88	2.68	4.47
Filtration	17.45	22.86	0.98	1.40	2.91
Chlorination	4.33	5.67	0.38	0.54	0.72
Misc. Piping (Sludge)	0.46	0.60	0.00	0.00	0.23
Flotation Thickening	2.10	2.75	0.30	0.43	0.35
Energy Recovery Unit	1.40	1.83	0.37	0.53	0.23
Anaerobic Digestion	7.99	10.47	0.62	0.88	1.33
Pump to Dewatering Equipment	0.50	0.66	0.01	0.01	0.01
Sludge Conditioning	0.81	1.06	1.04	1.48	0.14
Sludge Dewatering	17.70	23.19	0.78	1.11	2.96
500 Acres of Land	1.50	1.97	0.00	0.00	2.71
Reuse/Landfilling	1.95	2.55	0.15	0.21	0.40
Odor Control	6.26	8.20	0.04	0.06	1.05
Floodwater Relief Improvement/Leachate & Filtrate Return	0.61	0.80	0.02	0.03	0.14
Maintenance Facilities	1.50	1.97	1.04	1.48	0.25
Sewer Interceptors	43.52	57.01	0.96	1.37	21.76
SUBTOTAL	139.97	183.36	9.99	11.38	40.52
Less Credit for Power and Heating	0.00	0.00	1.61	2.30	0.00
TOTAL	139.97	183.36	8.29	9.08	40.52

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*Alternative 2B is comparable to the selected plan in the draft facilities plan.

SOURCE: CDM 1983c.

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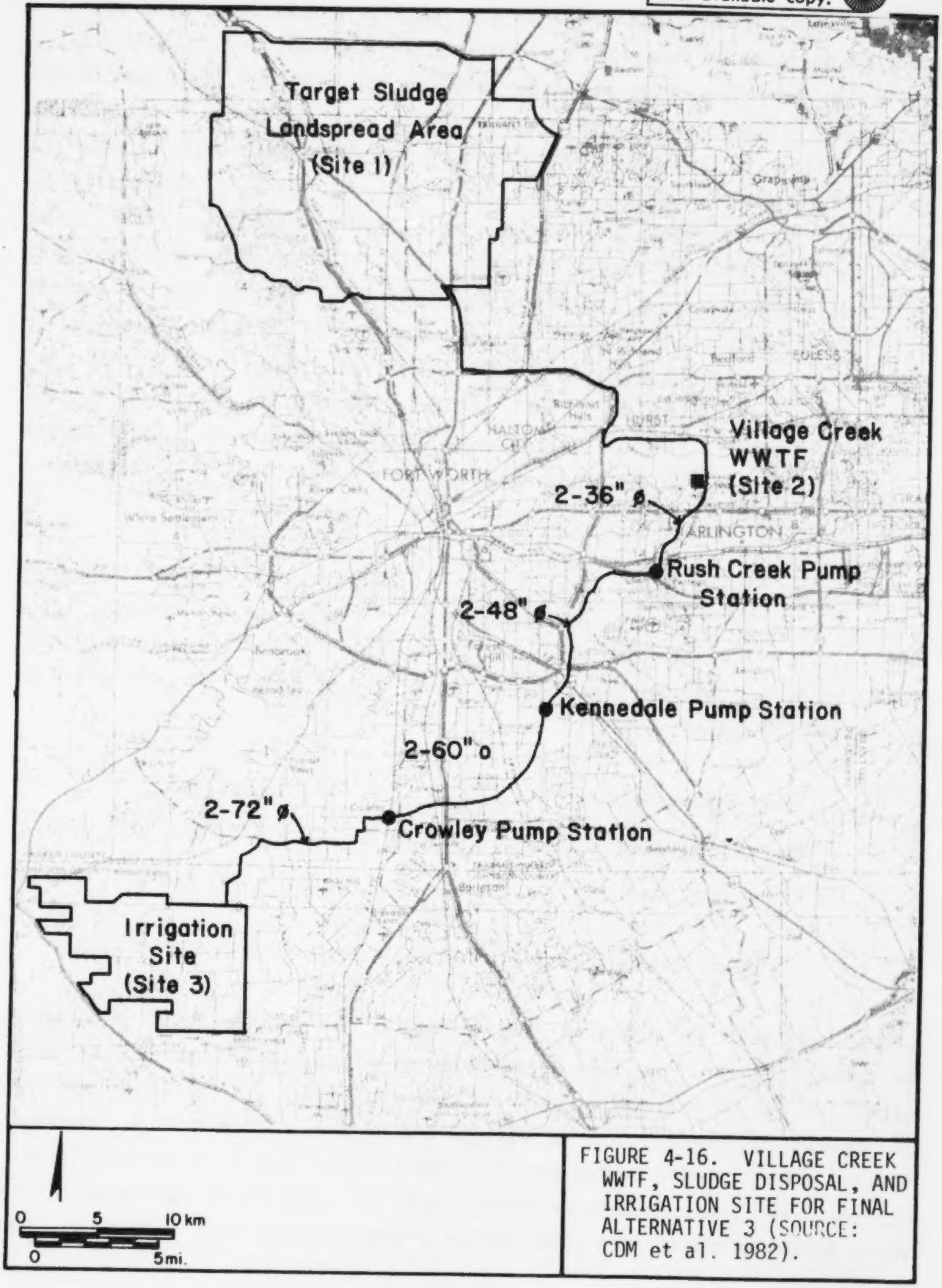

FIGURE 4-16. VILLAGE CREEK WWTF, SLUDGE DISPOSAL, AND IRRIGATION SITE FOR FINAL ALTERNATIVE 3 (SOURCE: CDM et al. 1982).

experienced at the Village Creek WWTF. The liquid treatment units utilized would be the same as described for Alternative 1 (refer to Section 4.7.1.1), but not as many new units would be required since 96 mgd would be treated instead of 137 mgd. New units which would be required at the Village Creek WWTF are listed in Table 4-30. Locations of new units which would be added at the Village Creek WWTF are illustrated in Figure 4-17. A schematic line diagram illustrating the path of wastewater through the treatment plant, flows to be treated, and the resulting quality of effluent for Alternative 3 is contained in Figure 4-18. As with the other final alternatives, the plant would be designed to meet 10/15 effluent limitations for both average daily flow and nominal daily flow conditions. Some wastewater would be directed around the secondary treatment (i.e., activated sludge) and advanced treatment (i.e., dual media filtration) units during high flow conditions. Grit removal and odor control practices would be the same as described for Alternative 1 (refer to Section 4.7.1.1).

The proposed upgrading of the 96 mgd Village Creek WWTF associated with Alternative 3 would involve energy (methane) recovery and utilization facilities similar to those described for Alternative 1. Total energy required, energy recovered, and net energy required at the Village Creek WWTF would be as follows (CDM et al. 1982):

Total Energy Required	176.5×10^6 kwh/yr
Energy Recovered	58.4×10^6 kwh/yr
Net Energy Required	118.1×10^6 kwh/yr

4.7.4.2 Liquid Treatment for Alternative 3 (Land Treatment)

Liquid treatment for the remaining 41 mgd of the 137 mgd design flow would be treated by the slow rate irrigation method of land treatment. An additional 12 mgd of wastewater would be conveyed to the Village Creek WWTF for preliminary treatment (i.e., screening) and primary treatment (i.e., sedimentation) prior to being pumped via force main to the land treatment site (i.e., Mustang Creek site) in Johnson County (Site 3). Additional wastewater flows would be collected at each pump station along the force main route (i.e., the

TABLE 4-30. NEW TREATMENT UNITS PROPOSED AT THE VILLAGE CREEK WWTF FOR ALTERNATIVE 3

New Treatment Unit Required	Number of Units Needed
Activated Sludge Aeration Tanks	1
Final Clarifiers	6
Dual Media Filters	6
Filter Backwash Storage Tank	1

SOURCE: CDM et al. 1982.

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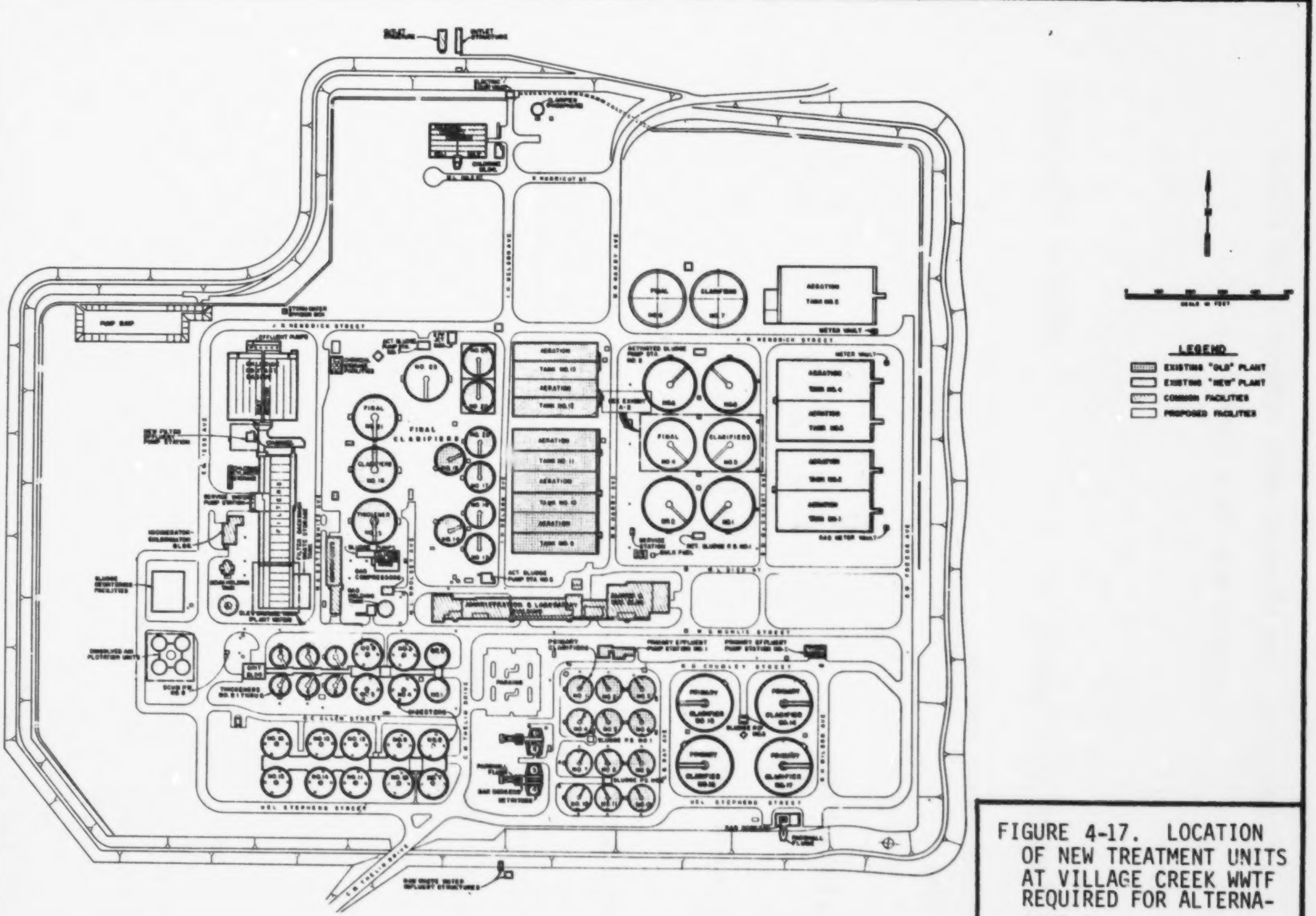

FIGURE 4-17. LOCATION OF NEW TREATMENT UNITS AT VILLAGE CREEK WWTF REQUIRED FOR ALTERNATIVE 3.

SOURCE: CDM et al. 1982.

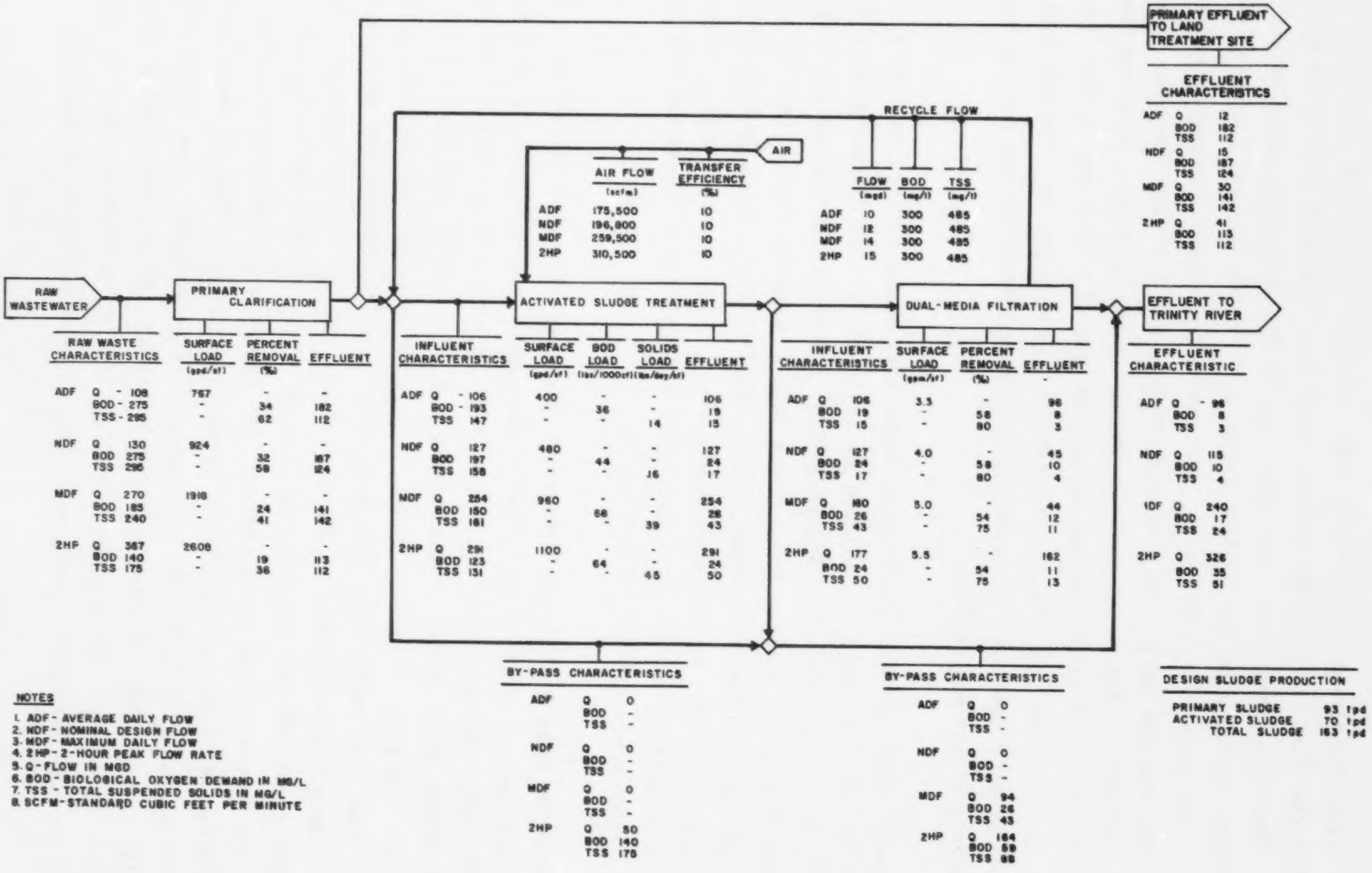

FIGURE 4-18. FLOW OF WASTEWATER, TREATMENT CAPACITY, AND EFFLUENT QUALITY OF TREATMENT UNITS PROPOSED FOR ALTERNATIVE 3 (SOURCE: CDM et. al. 1982).

Rush Creek, Kennedale, and Crowley pump stations illustrated in Figure 4-16) so that the flow reaching the Mustang Creek land treatment site would total 41 mgd. Dual pipelines (i.e., two pipelines of the same size) would be utilized to convey sewage from the Village Creek WWTF to the Mustang Creek irrigation site. The number of pipes used, flow velocity, and horsepower required to pump the average daily flow, maximum daily flow, and peak two-hour flow for each section of the force main is listed in Table 4-31. Good engineering practice requires velocities to be greater than 2.0 feet per second (fps) to keep solids from settling in the pipe. Oxygen would be injected into the sewage at each pump station to maintain aerobic conditions and provide partial treatment of the wastewater.

Wastewater arriving at the Mustang Creek site would receive secondary treatment in aerated lagoons, followed by chlorination and discharge to a 90-day capacity storage reservoir (Figure 4-19). Treatment and storage would involve approximately 600 acres. The aerated lagoon would be fully lined to prevent seepage and groundwater contamination. Approximately 10 to 14 tons of sludge per day would be generated by the aerated lagoon system, and periodically would be applied to the irrigated land in liquid form. Landspreading of liquid sludge would be limited to the rate of 2.6 tons per acre.

Wastewater from the storage pond would be pumped through a distribution system to slow rate irrigation sprinklers. Wastewater would be applied at a rate of 1.25 inches per week (65 inches per year) to agricultural land in the Trinity and Brazos River basins. Approximately 8,460 acres of land would be involved in the slow rate irrigation system. The City would neither purchase nor lease the land, but would sign contracts with local landowners who would agree to utilize all or a portion of their land for the irrigation process. The City would construct the necessary wastewater distribution and irrigation system on the farmer's land at no charge. The farmer would be responsible for maintaining the system and paying for operating expenses. The landowners would be required to distribute the wastewater (i.e., irrigate) when required by the City, and not when cropping practices dictated. During development of Alternative 3, several CAC members suggested that an irrigation district would be appropriate, but this concept was found to be undesirable by the City.

TABLE 4-31. FLOWS, VELOCITIES, AND PUMP HORSEPOWER REQUIRED FOR VARIOUS SEGMENTS OF THE FORCE MAIN TO THE IRRIGATION SITE FOR ALTERNATIVE 3

Flow (mgd)	Pipes Used	Velocity (ft/sec)	Pump Horsepower Required
• Village Creek PS to Rush Creek PS (2-36" dia. pipes 22,000 ft long)			
12 (ADF)	1	2.63	188
30 (MDF)	2	3.28	547
41 (2HP)	2	4.48	1,006
• Rush Creek PS to Kennedale PS (2-48" dia. pipes 39,000 ft long)			
30 (ADF)	1	3.69	820
75 (MDF)	2	4.68	2,541
102 (2HP)	2	6.16	4,767
• Kennedale PS to Crowley PS (2-60" dia. pipes 53,500 ft long)			
39 (ADF)	1	3.07	1,631
98 (MDF)	2	3.94	4,625
133 (2HP)	2	5.24	7,614
• Crowley PS to Mustang Creek Site (2-72" dia. pipes 74,900 ft long)			
41 (ADF)	1	2.24	2,395
103 (MDF)	2	2.82	6,210
139 (2HP)	2	3.80	9,260

SOURCE: ADAPTED FROM CDM et al. 1983.

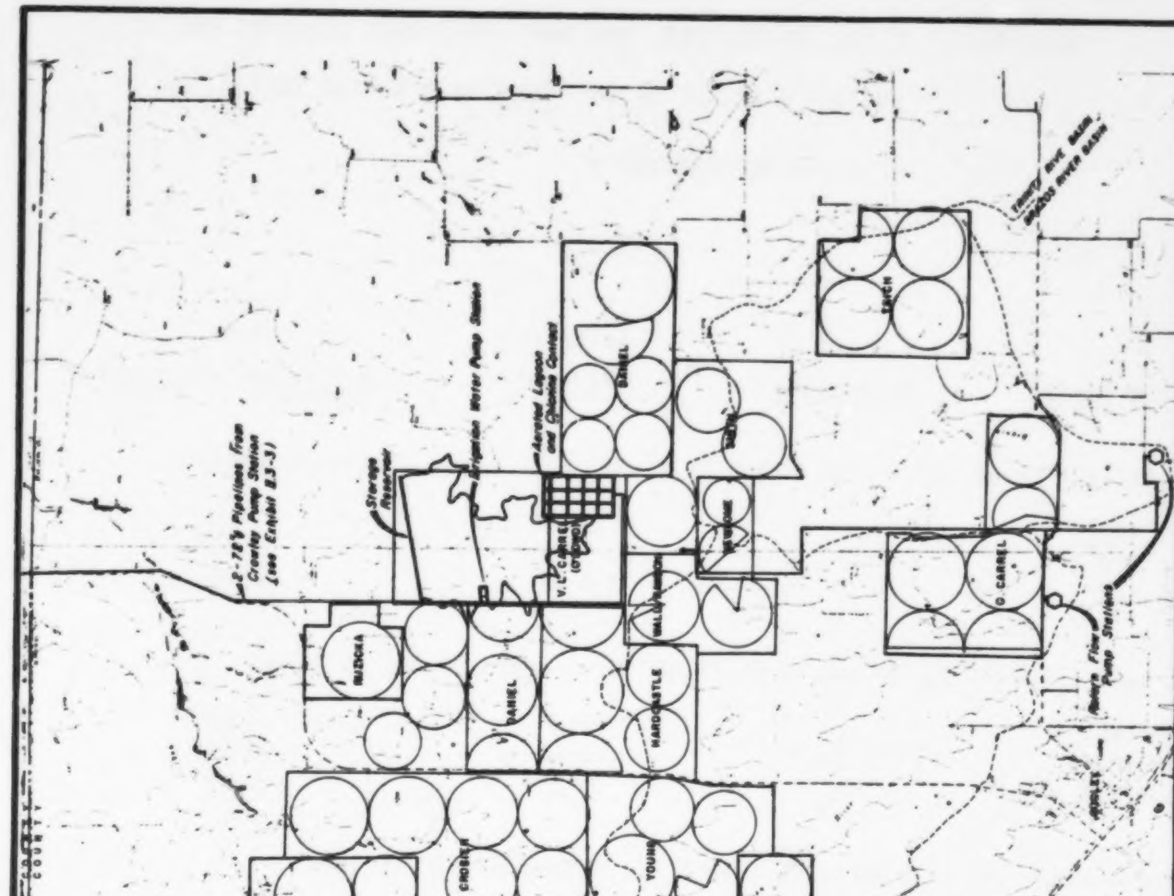

FIGURE 4-19. MUSTANG CREEK IRRIGATION AREA SITE PLAN FOR ALTERNATIVE 3 (SOURCE: CDM et al. 1982).

Wastewater applied in the Brazos basin (along with natural rainfall runoff) would be collected and pumped back to the Trinity basin. Underdrains under parts of the irrigation system constructed on shallow soils would discharge approximately 10 mgd of land treated effluent to Mustang Creek and thence to Lake Benbrook. The anticipated effluent quality which would be produced by the Village Creek WWTF liquid treatment system, the aerated lagoon system at Mustang Creek, and the slow rate irrigation land treatment system at Mustang Creek is listed in Table 4-32.

4.7.2.3 Sludge Treatment for Alternative 3

Sludge treatment and disposal facilities for handling sludge generated at the 96 mgd Village Creek WWTF would be very similar to the landspreading system described for Alternative 1. Approximately 93 dry tons of sludge per day would be hauled from the Village Creek WWTF in 30 cy trucks (15 - 24 round trips per day), along the same route as described for Alternative 1, to a 100-acre stockpile site adjacent to the assumed to be existing municipal refuse landfill. Ultimate sludge disposal would be by landspreading on 15,000 acres of farmland at an application rate of less than 2.6 tons per acre. The stockpile pad surface, surface water and groundwater protection systems, and information/release systems would be identical to those described for Alternative 1.

As stated previously, the small amount of sludge generated by the aerated lagoon at the Mustang Creek irrigation site would be disposed by landspreading in liquid form directly onto the irrigated lands. As with the other alternatives, the existing sludge drying beds located just northeast of the Village Creek WWTF would no longer be utilized on a daily basis, but would be retained for emergency use.

In summary, Alternative 3 would involve upgrading the Village Creek WWTF to treat 96 mgd at its present site (Site 2), with disposal of sludge by landspreading on 15,000 acres somewhere within a 60,000-acre sludge disposal target area north of Saginaw (Site 1), plus slow rate irrigation (land treatment) of 41 mgd of wastewater on 8,460 acres of land at the Mustang Creek

TABLE 4-32. ESTIMATED TREATED EFFLUENT CHARACTERISTICS FOR ALTERNATIVES 3

Parameter		Unit	Value for Average Daily Flow		
			Village Creek	Lagoon	Land
Flow:	1985	MGD	73	23	6
	2005	MGD	96	41	10
BOD		mg/l	8	30	2-5
TSS		mg/l	4	30	1-5
NH_3-N		mg/l	20	20	0.5-3
Total Solids		mg/l	750	NA	NA
Total Settleable Solids		ml/l	1	NA	NA
COD		mg/l	20	NA	NA
Total Phosphate		mg/l	5	6	0.1-2
Ortho-Phosphate		mg/l	4	5	0.1-1.5
ph		-	7	7	7
Metals					
AL		mg/l	2.50	2.50	NA
Cd		mg/l	0.03	0.03	0.01
Cr		mg/l	0.02	0.02	0.02
Cu		mg/l	0.03	0.03	0.03
Fe		mg/l	0.17	0.17	0.17
Mn		mg/l	0.01	0.01	0.01
Ni		mg/l	0.06	0.06	0.06
Pb		mg/l	0.04	0.04	0.04
Zn		mg/l	0.06	0.06	0.06

NA = Not Applicable.

SOURCE: ADAPTED FROM CDM et al. 1982.

site (Site 3) in Johnson County. Major components of Alternative 3 would include:

- New sewage collection lines (see Section 4.4.1);
- A new TRA transfer pipeline (see Section 4.3.5);
- New secondary treatment (activated sludge) units;
- New advanced treatment (dual media filtration) units;
- New sludge thickening and anaerobic digestion units;
- New energy recovery (methane gas) and utilization facilities;
- New mechanical dewatering (belt press) units;
- Odor control by chemical addition or other effective method at Village Creek WWTF;
- Trucking dewatered sludge to a 100-acre stockpile area north of Saginaw;
- Ultimate sludge disposal by surface landspreading 2.6 tons per acre per year on 15,000 acres of agricultural farmland and grassland;
- Transport of 41 mgd of wastewater via a force main from the Village Creek WWTF to the Mustang Creek irrigation site; and
- Treatment by aerated lagoon, storage and slow rate irrigation of 41 mgd of wastewater distributed on 8,460 acres of land in Johnson County.

Estimated costs of capital improvements (both grant eligible and ineligible), operation and maintenance costs, and salvage values remaining after a 20-year planning period for the components of Alternative 3 are listed in Table 4-33.

4.8 COST-EFFECTIVENESS ANALYSIS OF THE FOUR FINAL ALTERANTIVES

The City developed information concerning the anticipated costs of constructing the four final alternatives (construction cost); the total project costs including engineering, contingency, and administrative fees which would be incurred (capital cost); the estimated yearly cost of operating and maintaining the facilities (annual O&M); and the value treatment equipment and/or structures would have at the end of the 20-year planning period (salvage value). This cost information is presented in detail in the City's draft facilities plan (CDM et al. 1983).

TABLE 4-33. ESTIMATED COSTS BY COMPONENT FOR ALTERNATIVE 3 FOR THE FORT WORTH SYSTEM (IN MILLIONS OF DOLLARS)

	Construction Cost	Capital Cost	Annual O&M Cost		Salvage Value
			1985	2005	
• Improvements at Village Creek					
Preliminary Treatment	0.33	0.43	0.50	0.30	0.06
Primary Treatment	0.00	0.00	0.40	0.40	0.00
Pump to Sec. Treatment	0.12	0.16	0.36	0.36	0.02
Secondary Treatment	11.84	15.51	1.88	1.88	1.97
Filtration	11.76	15.41	0.98	0.98	1.96
Chlorination	0.00	0.00	0.38	0.38	0.00
Misc. Piping (Sludge)	0.46	0.60	0.00	0.00	0.23
Flotation Thickening	2.10	2.75	0.30	0.30	0.00
Gravity Thickening	0.00	0.00	0.03	0.03	0.00
Energy Recovery Unit	0.10	0.13	0.37	0.37	0.02
Anaerobic Digestion	4.00	5.24	0.55	0.55	0.67
Pump to Dewatering Equip.	0.05	0.07	0.08	0.08	0.01
Sludge Conditioning	0.42	0.55	0.69	0.69	0.07
Sludge Dewatering	6.66	8.72	0.60	0.60	1.11
Truck to Land Spread Site	0.46	0.60	0.40	0.40	0.00
100 Acres of Land	0.20	0.26	0.00	0.00	0.36
Maintenance & Admin.	1.50	1.97	1.04	1.04	0.25
Stockpiling	2.16	2.83	0.01	0.01	0.36
Land Spreading (Sludge)	5.74	7.52	0.66	0.66	0.00
Odor Control	4.99	6.54	0.03	0.03	0.83
Sewer Interceptors	21.75	28.50	0.90	0.90	10.88
SUBTOTAL	74.64	97.79	10.16	10.16	19.15
• Additional at Village Creek					
Preliminary Treatment	0.30	0.39	0.05	0.05	0.05
Pumping to Secondary	0.12	0.16	0.04	0.04	0.02
Primary Treatment	0.00	0.00	0.04	0.04	0.00
SUBTOTAL	0.42	0.55	0.13	0.13	0.07
• Additional Land Treatment (41 mgd)					
Pump to Mustang Creek	84.54	110.75	0.65	2.61	38.92
Two Return Flow Pump Sta.	0.20	0.26	0.01	0.03	0.03
Land Application	39.61	51.89	0.23	0.91	18.19
SUBTOTAL	124.35	162.90	0.89	3.55	57.14
TOTAL (Before Credits)	199.41	261.24	11.18	13.84	76.36
Less Credit for Power and Heating	0.00	0.00	1.38	1.38	0.00
TOTAL	199.41	261.24	9.80	12.46	76.36

SOURCE: CDM 1983c.

Capital costs are given in terms of total dollars required to finance the project in one lump sum payment. Operation and maintenance costs, however, are given as an annual cost to be spent each year during the 20-year planning period. If one alternative has a high capital cost but a low O&M cost, while a second alternative has a low capital cost but a high annual O&M costs, it is difficult to compare the two alternatives to tell which one really would be cheapest over-all. In order to enable a meaningful comparison to be made, a cost-effectiveness analysis must be conducted.

The cost-effectiveness analysis presents all cost information in terms of present worth at the beginning of the planning period. Capital cost, present worth of the annual O&M, and present worth of the salvage value at the end of the planning period are summed to obtain the total present worth of each alternative. Cost information contained in this EIS is presented in a different format than cost information presented in the draft facilities plan in order to provide a concise, equal basis, cost comparison for the alternatives.

During conduct of the cost-effectiveness analysis, it was recognized that some alternatives involving resource recovery potentially contain extraneous items of value. An alternative involving landspreading of sludge containing valuable nutrients, for example, results in landowners being able to operate their agricultural programs for less cost because they no longer have to purchase as much expensive fertilizers. EPA Region 6 has allowed "credits" in certain circumstances for alternatives which return valuable resources to the land. Items involved with the City of Fort Worth's four final alternatives which potentially would qualify for consideration of credit values include: (1) value of sludge applied to land; (2) value of irrigation water (wastewater) applied to land; and (3) value of treated wastewater returned to Lake Benbrook to supplement raw drinking water supplies. Potential credits available for these systems were evaluated as follows:

- Value of Sludge Applied to Land. The fact that municipal sewage sludge contains valuable nutrients is well recognized. Recent evaluations made by the SCS and EPA Region 6 have determined that municipal sewage sludge can be worth up to $20/ton when used in bulk form for agricultural purposes, and can be worth up to $70/ton when used for special purposes such as placement on municipal parks and golf courses (USEPA 1981e). Alternatives 1 and 3 would involve landspreading of sewage sludge for agricultural purposes. Preliminary calculations indicate that, based on nitrogen content, the City's sludge is worth $10/ton in dry form and $15/ton in liquid form. Additional trace metals potentially increase the value of the sludge. For cost evaluation purposes, a value of $20/ton was used. This would mean that Alternative 1 potentially would be eligible for a credit of: 154 tons/day X 365 days/year X $20/ton = $1.1 million per year;

Similarly, Alternative 3 potentially would be eligible for a credit of: (93 + 14) tons/day X 365 days/year X $20/ton = $0.8 million per year.

- Value of Wastewater Applied to Land. The fact that wastewater applied to land for irrigation has a value also is well recognized. Wastewater often contains nitrogen, phosphorus, potassium, and trace metals similar to those found in sewage sludge. Based on an average of 3.0 mg/l of usable nitrogen in wastewater, the City's aerated lagoon wastewater is worth approximately $1.67 per million gallons as a liquid fertilizer. At an irrigation rate of 65 inches per year, this is equivalent to $2.95/acre. However, many farmers believe that they would not have to fertilize their land at all once wastewater is applied, thus saving them their entire cost of fertilization which often costs $25 per acre per year. For cost evaluation purposes, Alternative 3 potentially would be eligible for a credit of: $25 per acre per year X 8460 acres = $0.2 million per year; and

- Value of Wastewater Returned to Lake Benbrook. Wastewater effluent from land application systems typically is of an excellent quality. Wastewater entering Lake Benbrook at a rate of 10 mgd would supplement local water supplies, potentially negating the necessity of pumping 10 mgd from the Tarrant County WCID No. 1's proposed Richland-Chambers reservoir. Preliminary calculations indicate this could save the Tarrant County WCID No. 1 approximately $0.0843 per 1000 gallons in pumping costs. Thus, Alternative 3 involving 10 mgd of land application effluent discharged to Lake Benbrook potentially would be eligible for a credit of: 20 mgd X $0.0843 per 1000 gallons X 365 days per year = $0.3 million per year.

For a 20-year planning period, Alternative 1 might be eligible for a credit of $11.1 million (i.e., present worth of $1.1 million/year for 20 years). Similarly, Alternative 3 might be eligible for a credit of $13.1 million. Although EPA Region 6 has allowed such credits to be considered in cost-effectiveness analyses, the Texas Department of Water Resources (TDWR), the agency which administers construction grant projects in Texas, has not accepted such conditions (Lock 1983). It should be understood that the City would actually receive little or no monetary benefits from the systems discussed as being worth a "credit"; i.e., revenues for offsetting the City's cost of wastewater management would not be received and placed in the City's water/sewer fund. The concept of allowing "credits" is an evaluation tool which enables the cost-effectiveness analysis to account for the value to the general public of certain wastewater treatment alternatives in other categories besides wastewater management. Allowing "credits" in the cost-effectiveness analysis does not actually reduce monthly sewer user charges (i.e., monthly sewer bills) paid by users of the wastewater system.

The results of the cost-effectiveness analysis of the four final alternatives for the Village Creek WWTF are presented in Table 4-34. The top one-half of the table presents the cost-effectiveness analysis of the alternatives without allowing any credit for resource recovery. The bottom one-half of the table presents an analysis which does consider credits for resource recovery systems. In both analyses Alternative 2B, the concept of expanding the Village Creek WWTF and disposing sludge in a landfill in the Trinity River floodplain, is the least cost system.

The construction grants program, although administered by the TDWR, is a Federal program which makes Federal grants available for construction of wastewater treatment facilities. For grants awarded prior to 1 October 1984, the Federal grant would equal 75 percent of all grant eligible capital costs. On or after 1 October 1984, the Federal share would be 55 percent of all grant eligible capital costs. EPA participation in cost for reserve capacity has been reduced from 20 years to the capacity needed at the time of grant award. Grants are not awarded for annual operation and maintenance expenditures.

For innovative/alternative components such as the energy (methane) recovery units and resource recovery systems (e.g., sludge landspreading and slow-rate irrigation) proposed in several of the four final alternatives for the Village Creek WWTF, grants of up to 85 percent of the costs of the innovative/alternative systems can be awarded prior to 1 October 1984. On or after 1 October 1984, innovative/alternative systems may receive up to 75 percent grants. However, an innovative/alternative system must have a present worth within 115 percent of the cost of the lowest cost conventional system in order to receive any grant at all. A review of the last column in Table 4-34 indicates that Alternative 3 potentially would not be eligible for a construction grant, since it cost more than 115 percent of the least cost alternative.

TABLE 4-34. COST-EFFECTIVENESS ANALYSIS OF THE FOUR FINAL ALTERNATIVES FOR THE FORT WORTH SYSTEM (MILLIONS OF DOLLARS)

Alternatives	Total Capital Cost	Annual Operation & Maintenance		P.W. O&M (11.6379)	Salvage Value	P.W. Salvage Value (0.2410)	Total P.W.	Total Annual Equivalent (0.0990)	% of Lowest Alter.
		1985	2005						
1	179.78	9.29	13.23	131.04	38.03	9.16	301.66	29.86	110
2A	182.04	8.66	12.43	122.72	39.12	9.42	295.34	29.24	107
2B	183.36	8.29	9.08	101.76	40.52	9.77	275.35	27.26	100
3	261.24	9.80	12.46	129.53	76.36	18.40	372.37	36.86	135

COST-EFFECTIVENESS OF THE FOUR FINAL ALTERNATIVES WITH A CREDIT GIVEN FOR RESOURCE RECOVERY SYSTEMS (MILLIONS OF DOLLARS)

Alternatives	Total Capital Cost	Annual Operation & Maintenance		P.W. O&M (11.6379)	Salvage Value	P.W. Salvage Value (0.2410)	Total P.W.	Total Annual Equivalent (0.0990)	% of Lowest Alter.
		1985	2005						
1	179.78	9.29	13.23	119.94[a]	38.03	9.16	290.56	28.77	105
2A	182.04	8.66	12.43	122.72	39.12	9.42	295.34	29.24	107
2B	183.36	8.29	9.08	101.76	40.52	9.77	275.35	27.26	100
3	261.24	9.80	12.46	116.43[b]	76.36	18.40	359.27	35.57	130

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[a] Includes a credit of $11.1 million.
[b] Includes a credit of $13.1 million.

SOURCE: CDM 1983c.

The City's project schedule indicates a construction grant would be awarded prior to 1 October 1984. For the purposes of cost comparison user charges were developed for this EIS based on various funding possibilities. At this time, no eligibility determinations have been made for any of the proposed facilities. With this basis, the local project share of the capital cost, annual O&M, total project cost, and anticipated monthly user fee for each alternative for various funding possibilities are as shown in Tables 4-35, 4-36, and 4-37. The estimated monthly user fee is presented only for comparision purposes; actual monthly sewer charges assessed by the City would depend upon actual funding provided, bond rates, time of bond issuance, and other factors. In addition, the project built by the City would be constructed in phases, and monthly sewer charges would vary through each year of bond retirement and each phase of construction.

4.9 IDENTIFICATION OF GRANT APPLICANT'S PREFERRED ALTERNATIVE

After review and evaluation of the four final alternatives and consideration of input from City staff, the CAC, the general public via public meetings, and the City's engineering consultants, the City Council selected Alternative 2B as the City's preferred alternative. Alternative 2B would involve expanding the Village Creek WWTF to a capacity of 137 mgd average daily flow, with a design effluent quality of 10/15 (BOD/TSS) discharged to the Trinity River. Sludge produced at the Village Creek WWTF would be pumped through two (2) twelve inch diameter pipes to a 500 acre site across the Trinity River, mechanically dewatered, and disposed in a sludge only landfill occupying approximately 100 acres with an ultimate disposal goal of beneficial reuse. A cost-effectiveness analysis determined Alternative 2B to be the least cost alternative available to the City. The City must have an NPDES permit from EPA and WCO permit from the TDWR for any wastewater discharge. Implementation of Alternative 2B also may require a Section 10 and a Section 404 permit from the US Army Corps of Engineers.

In order to allow construction to match growth and to avoid a single, enormously high capital expenditure, the City proposes to construct Alternative 2B in three major phases. Phase I would upgrade the existing 96 mgd plant and provide units necessary to properly treat high flows (i.e., peaks of 3.2 times

TABLE 4-35. ESTIMATED LOCAL COST AND ADDITIONAL MONTHLY USER CHARGE FOR FOUR FINAL ALTERNATIVES FOR THE FORT WORTH SYSTEM (BASED ON 75%/85% FUNDING)

Alternatives	Local Share of Capital Cost (Millions)	P.W. O&M (Millions)	Salvage (Millions)	Local Commitment Total P.W. (Millions)	Total Annual (0.0990) (Millions)	Additional Monthly Cost Per Connection[a] (Dollars)
1	44.95	131.04	9.16	166.83	16.52	5.89
2A	45.51	122.72	9.42	158.81	15.72	5.60
2B	45.84	101.76	9.77	137.83	13.65	4.86
3	39.19	129.53	18.40	150.32	14.88	5.31

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[a] Curent sewer bills average $5.60/month

SOURCE: CDM 1983c.

TABLE 4-36. ESTIMATED LOCAL COST AND ADDITIONAL MONTHLY USER CHARGE FOR FOUR FINAL ALTERNATIVES FOR THE FORT WORTH SYSTEM (BASED ON 55%/75% FUNDING)

Alternatives	Local Share of Capital Cost (Millions)	P.W. O&M (Millions)	Salvage (Millions)	Total P.W. (Millions)	Total Annual (0.0990) (Millions)	Additional Monthly Cost Per Connection[a] (Dollars)
1	80.90	131.04	9.16	202.78	20.08	7.16
2A	81.19	122.72	9.42	194.49	19.25	6.87
2B	82.51	101.76	9.77	174.50	17.28	6.16
3	65.31	129.53	18.40	176.44	17.46	6.23

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[a] Current sewer bills average $5.60/month

SOURCE: CDM 1983c.

TABLE 4-37. ESTIMATED LOCAL COST AND ADDITIONAL MONTHLY USER CHARGE FOR FOUR FINAL ALTERNATIVES FOR THE FORT WORTH SYSTEM (BASED ON NO FEDERAL FUNDING)

Alternatives	Local Share of Capital Cost (Millions)	P.W. O&M (Millions)	Salvage (Millions)	Total PW (Millions)	Total Annual (0.0990) (Millions)	Additional Monthly Cost Per Connection[a] (Dollars)
1	179.78	131.04	9.16	301.66	29.86	10.65
2A	182.04	122.72	9.42	295.34	29.24	10.43
2B	183.36	101.76	9.77	275.35	27.26	9.72
3	261.24	129.53	18.40	372.37	36.86	13.15

---

[a] Current sewer bills average $5.60/month

SOURCE: CDM 1983c.

the average daily flow). Phase I would not provide additional liquid treatment capacity beyond 96 mgd. Phase I construction would be conducted in the following three parts:

- Phase IA -- would involve adding liquid treatment units to handle high flows at the Village Creek WWTF;
- Phase IB -- would involve adding sludge treatment units and the proposed landfill; and
- Phase IC -- would involve adding odor control (i.e., chemical addition) equipment and other facilities or programs.

Phase I also would involve improving and/or constructing the following sewage collection lines: Village Creek, Clear Fork, West Fork, a 72" interceptor (M-245), and the TRA interconnection line.

Phase II would involve adding liquid treatment units at the Village Creek WWTF to expand the capacity to 120 mgd. Odor control facilities needed with the new liquid treatment units also would be constructed. In addition, Phase II would involve further improvements to the Village Creek and Clear Fork interceptors.

Phase III also would be completed in two parts:

- Phase IIIA -- would involve adding additional liquid treatment units to expand the plant to 137 mgd; and
- Phase IIIB -- would involve adding additional sludge treatment facilities at the plant.

In addition, Phase III would involve further improvements to the following interceptors: Village Creek, Clear Fork, West Fork, Walker Branch, and a 96" interceptor (M-280).

A schedule for implementing the various phases of the City's preferred project, Alternative 2B, was developed as illustrated in Figure 4-20. A graphic illustration (Figure 4-21) of the design flow and flow variations which would occur for each phase of the proposed implementation plan also was

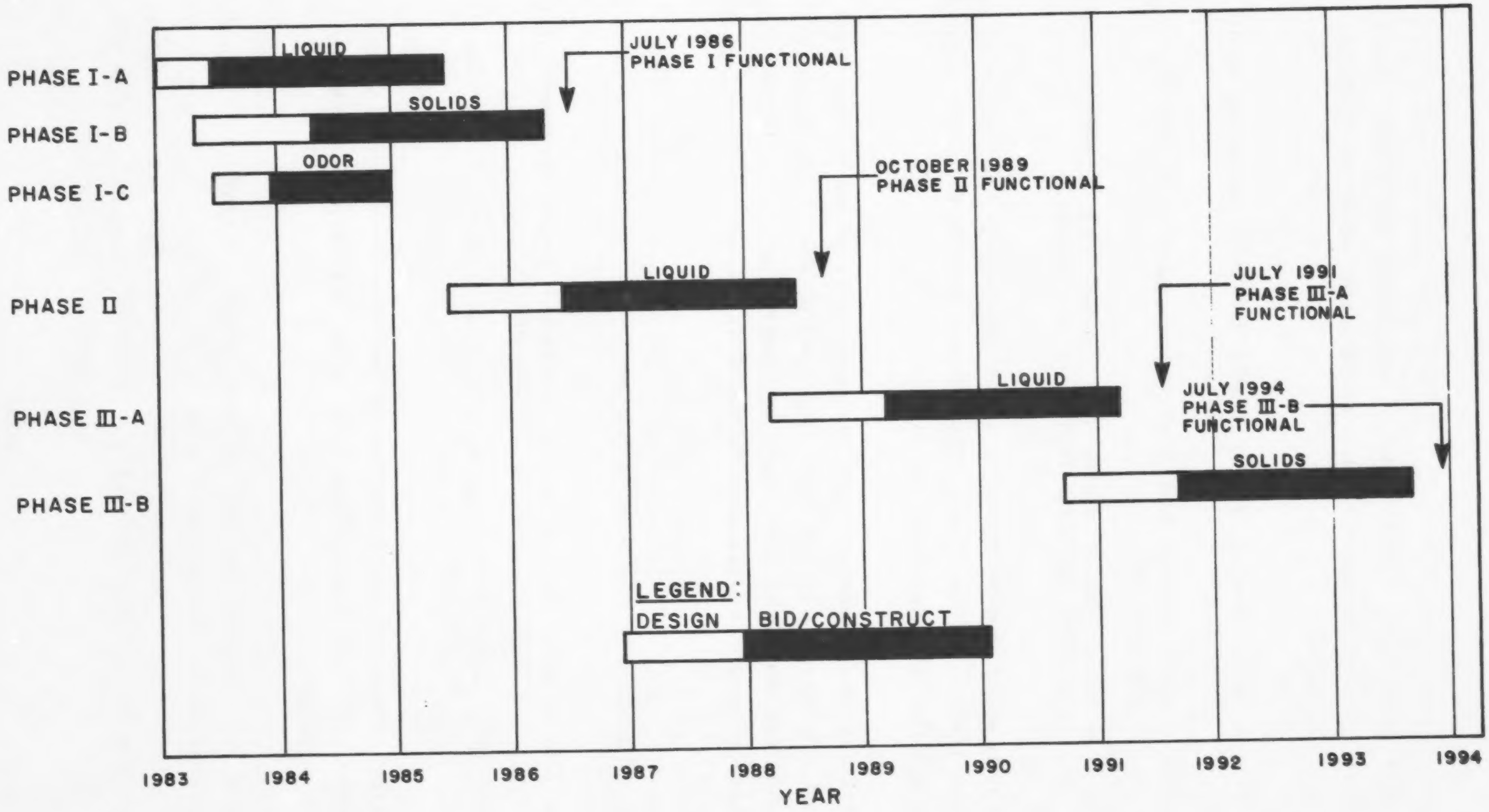

FIGURE 4-20. PROPOSED SCHEDULE FOR DESIGNING AND CONSTRUCTING ALTERNATIVE 2B, THE CITY'S PREFERRED ALTERNATIVE (SOURCE: CDM et al. 1983).

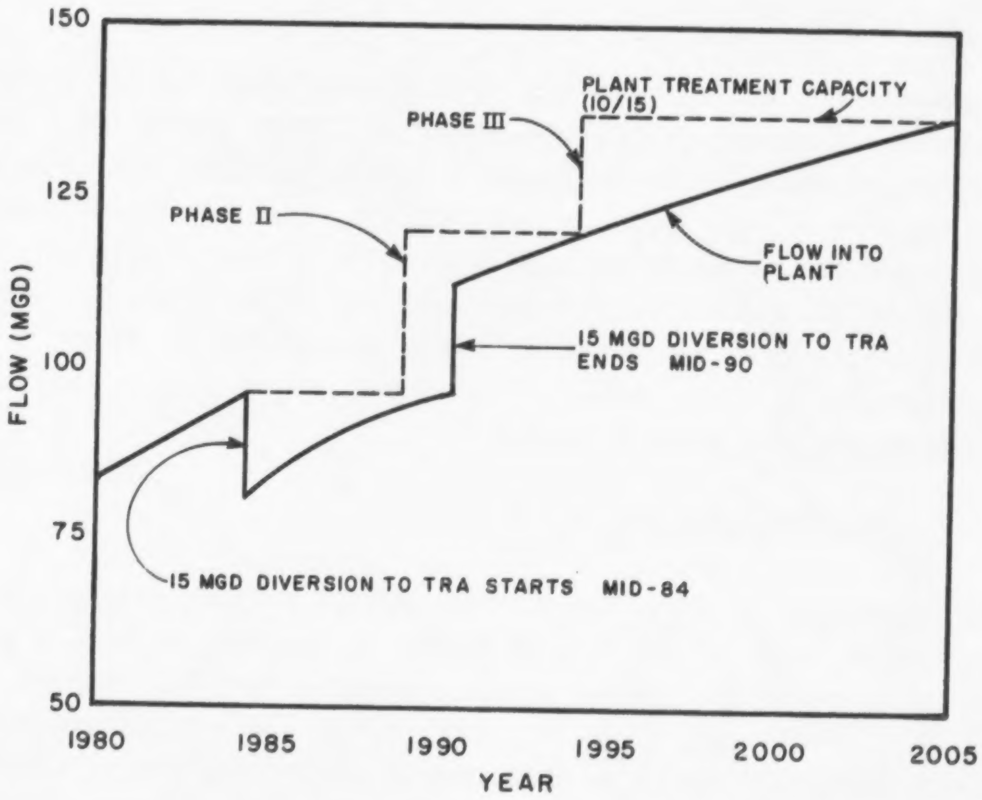

FIGURE 4-21. DESIGN FLOW AND FLOW VARIATIONS ASSOCIATED WITH EACH PHASE OF THE PROPOSED IMPLEMENTATION OF ALTERNATIVE 2B (SOURCE: CDM et al. 1983).

developed. Various bond programs would be implemented to finance construction and operation of each phase. Also, additional users potentially would be available each year, due to constant growth in the planning area, to pay for the Alternative 2B improvements. Estimated total monthly user charges from now to the end of the planning period (i.e., 1982 to 2005) for various funding possibilities for construction and operation of Alternative 2B are listed in Tables 4-35, 4-36, and 4-37.

The community's financial capability also was evaluated for the preferred alternative. According to the EPA guidelines (USEPA 1982b) total annual charges to customers should not exceed 1.75% of the 1980 annual household median income when that income is over $17,000. The 1979 annual household median income for Tarrant County adjusted to 1980 dollars is $17,294. Table 4-38 presents the percentages of annual household median income to the total annual cost at project completion, at various funding levels. At all funding levels the cost of the preferred alternative would not be a burden to the community according to those guidelines.

4.10 ALTERNATIVES AVAILABLE TO EPA

Two basic alternatives are available to EPA through the TDWR: (1) awarding of a construction grant to the City of Fort Worth, and (2) denial of a grant. Grant denial constitutes the no action alternative for EPA. A grant could amount up to 75 percent of the eligible cost of constructing conventional treatment facilities, and up to 85 percent of the eligible cost of constructing innovative/alternative technology facilities. After October 1984 any funding would be limited to 55 percent of the eligible portion of the cost of constructing conventional treatment facilities and 75 percent of the eligible portion of the cost of constructing innovative/alternative technology facilities. A grant agreement also can be modified by EPA placing conditions on the grant. The City of Fort Worth would be required to meet the NPDES and WCO permit requirements regardless of the amount of funding received.

EPA participated in the expansion of the Village Creek WWTF to 96 mgd annual average daily flow under grant No. C-481017. Any additional work required at the plant to achieve a treatment capacity of 96 mgd annual average daily flow

TABLE 4-38. DEMONSTRATION OF COMMUNITY FINANCIAL CAPABILITY FOR ALTERNATIVE 2B, AT 75/85%, 55/75%, AND NO FEDERAL FUNDING LEVELS, IN 1980 DOLLARS

Federal Funding Level	ESTIMATED TOTAL ANNUAL BILL AT PROJECT COMPLETION Current Annual Sewer Bill	Additional Annual Sewer Bill	Total	PERCENT OF 1980 HOUSEHOLD MEDIAN INCOME* TO TOTAL ANNUAL COST FOR THE PREFERRED ALTERNATIVE
75/85%	$67.20	$58.43	$125.63	0.73%
55/75%	$67.20	$73.97	$141.17	0.82%
0%	$67.20	$116.69	$183.89	1.06%

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* 1979 Annual household median income ($15,304) adjusted to 1980 dollars (using Consumer Price Index of 1.13) = $17,294.

SOURCE: ADAPTED FROM CDM 1983c.

would not be allowable for EPA participation. In addition, any existing treatment unit abandoned or replaced before its useful life has expired would be subject to EPA's policy on abandonment of construction grant assisted publicly owned treatment works.

4.11 ALTERNATIVES AVAILABLE TO OTHER AGENCIES

The Texas Department of Water Resources also has two funding alternatives: (1) awarding of a construction grant to the City of Fort Worth, and (2) denial of a grant. In addition, the US Army Corps of Engineers can issue or deny a Section 404 and/or a Section 10 permit for those project alternatives that require a USCOE permit prior to construction.

5.0 ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES

This chapter describes existing conditions and how existing conditions would be changed or affected due to implementation of any one of the four final alternatives described in Chapter 4.0.

Potential effects of the four final alternatives are described and evaluated with respect to the following 12 disciplines, or topic categories: earth resources (5.1), groundwater resources (5.2), surface water resources (5.3). air and sound quality (5.4), biological resources (5.5), cultural resources (5.6), population (5.7), land use (5.8), transportation and community services (5.9), socioeconomics (5.10), energy resources (5.11), environmental health (5.12), and recreation and aesthetics (5.13). Chapter 5.0 concludes with a summary of potential mitigative measures, adverse impacts which cannot be avoided, and irretrievable commitments of resources and productivity relationships associated with the project (5.14).

A brief explanation is needed concerning evaluation of the effects of alternatives which presume that a municipal refuse landfill would be built and in operation in the sludge disposal target area north of Saginaw (i.e., Alternatives 1, 2A and 3). Since the City's present landfill would reach capacity in 2 to 3 years, the City soon would be building a new landfill for solid waste disposal, regardless of how sludge from the WWTF is disposed. Certain effects or events potentially would occur when the new landfill is built, such as:

- dust may occur due to construction activities;
- noise levels may increase due to landfill construction;
- the topography, or shape of the ground's surface, may be altered due to landfill construction and operation;
- land values in the immediate vicinity of the landfill may be altered; and

- traffic patterns on roadways near the new landfill may be altered due to the presence of garbage trucks going to and from the landfill.

Although these are only a few of the effects that may occur, the point of the discussion is this: effects such as those listed above would occur when the new landfill is built, regardless of whether or not sanitary sludge is stockpiled adjacent to or placed in the landfill. Therefore, when describing and evaluating environmental effects that would occur due to stockpiling or landfilling sludge in the target area north of Saginaw, this EIS only describes and evaluates effects that are associated with transportation and placement of sludge, and not effects of the municipal refuse landfill activities in general.

5.1 EARTH RESOURCES

5.1.1 Existing Conditions

5.1.1.1 Topography

A combination of alternating hard and soft geological strata in addition to a well developed drainage has allowed for development of a striking diversity of landforms in the project region. The project region is divided by four geologic sections, or belts, which are oriented southwest to northeast and which are clearly marked by soil, plant and topographic characteristics. These geologic sections are termed (from west to east) the Western Cross Timbers, the Grand Prairie, the Eastern Cross Timbers, and the Black Prairie province. Inequalities in hardness and composition of underlying clays and shell marl in the headwaters of the Trinity River (i.e., in the western portion of the project region) have produced dissected sections typified by steep hills, narrow valleys, frequent waterfalls, cliffs and small rapids. Hills are characterized by indented and irregular ridges converging toward the Trinity River valley. In the eastern portion of the project region, where the underlying strata layout is not as complex as in the Trinity River headwaters, the surface is characterized by a cuesta topography, (i.e., parallel escarpments facing westward). A gentle dip of strata in a southeasterly direction has in general resulted in long gentle slopes on the southeast side of cuesta uplands and rather abrupt slopes on the northwest side of the uplands formed due to successive ledges of formations emerging from below the surface. In general, escarpments become less pronounced to the east due to the geologic formations being more uniform and evenly distributed towards the east. Figure 5-1 indicates the general topography and locations of the four geologic sections of the project region. Ground elevations range in altitude from approximately 940 feet mean sea level (msl) in the southwest, to approximately 420 feet msl along the Trinity River at the eastern boundary of Tarrant County.

With respect to the specific project sites, Site 1 (Figure 5-1) is located primarily in the Grand Prairie topographic province, although the western edge of the site crosses into the Western Cross Timber province. The topography is primarily flat and terraced, caused by the weathering of limestone outcrops into upland surfaces. Upland slopes consist mainly of erosion slopes dipping in the direction of strata dip and toward the drainage. The western portion of the area becomes hilly, characteristic of the Western Cross Timbers province.

The Eastern Cross Timbers also is characterized by gently rolling hills. Site 2 is located within the Grand Prairie and Eastern Cross Timber topographic section; however, Site 2 is located within the floodplain of the Trinity River. The topography is therefore flat or gently sloping which is characteristic of the floodplain alluvium between the hills to the north and south.

Site 3 is located along the boundary of the Western Cross Timbers and Grand Prairie provinces. The topography again consists of gently rolling hills to the west, flattening to rolling plains and upland terraces in the east. The western hills are dissected into steeper hills and deep laterals of the Trinity River, with frequent waterfalls, cliffs and small rapids located along the western edges of the site.

The project region lies entirely within the drainage of the Trinity River. The Clear Fork drains the northwestern part of the project region and the West Fork drains the southwestern part of the project region, while the eastern

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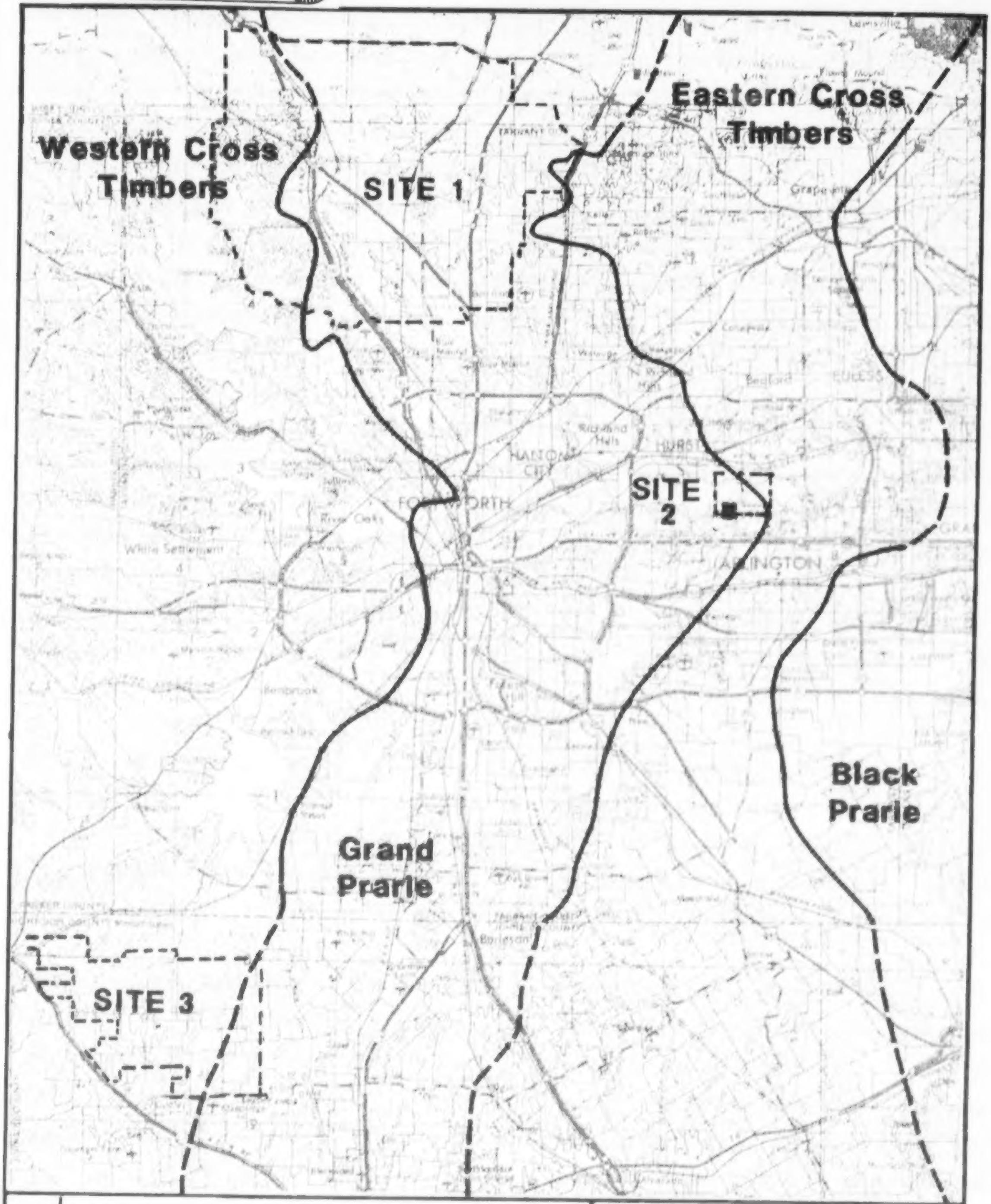

FIGURE 5-1. GENERAL TOPOGRAPHY AND TOPOGRAPHIC SECTIONS WITHIN THE PROJECT REGION (SOURCE: ADAPTED FROM LEGGAT 1957).

portion is drained by smaller laterals of the Trinity, such as Village Creek. Project Site 1 is drained by the West Fork of the Trinity River, which heads in Archer and Clay counties. Project Site 2 is drained by Sycamore, Village, Fossil, and Bear creeks and other intermittent tributaries of the West Fork. Project Site 3 is located within two major basins; the northeast portion of the project site is within the Trinity River basin, and the southwest portion within the Brazos River basin.

5.1.1.2 Geology

Except for sediments of Quaternary age which lie just above and in the floodplains, geologic formations in the project region are of Cretaceous age. The geologic formations lie in more or less parallel bands or outcrops extending across the project region in a northwest to southeast direction. Table 5-1 lists the thickness of various geologic formations in the project region and gives a brief description of their characteristics, topographic features, and water bearing properties. Outcrops of formations in the project region are shown in Figure 5-2 (Note: the legend for Figure 5-2 is presented as Figure 5-3).

The Cretaceous system has a maximum thickness of about 2,100 feet in the project region, and is divided into the Comanche and Gulf series. The Comanche series includes eastward-dipping rocks of the Trinity, Fredericksburg and Washita groups and forms the surface of the Western Cross Timbers and the Grand Prairie belts. Sedimentary rocks of the Comanche series are of near-shore or epicontinental origin and consist primarily of limestone. The Comanche series has a maximum thickness of about 1,600 feet at the eastern edge of the project region.

The Trinity River group, the outcrop of which underlies the Western Cross Timbers belt, includes the Travis Peak formation, the Glen Rose limestone and the Paluxy sand and has a maximum thickness of about 1,070 feet in the project region.

TABLE 5-1. GEOLOGIC FORMATIONS IN TARRANT COUNTY, TEXAS.

	Series and group	Formation and member	Thickness (feet)	Character of rocks	Topographic expression	Water-bearing properties
Quaternary	Recent and Pleistocene	Alluvium	0- 45	Sand, gravel, clay and silt.	Terrace and flood-plain deposits.	Small to moderate yields. Water unsatisfactory for domestic use unless treated.
Cretaceous	Gulf series	Eagle Ford shale	0-200	Bluish-black shale; thin sandstone and limestone beds.	Gently, rolling, treeless, black waxy soil. Forms Black Prairie belt.	Not known to yield water to wells in Tarrant County.
		Woodbine formation Lewisville member	$0-200^+$	Ferruginous sandstone, vari-colored clay and sandy clay, lignite, and gypsum.	Low hills, sandy soils, heavily wooded with oaks. Forms Eastern Cross Timbers belt.	Yields small supplies of water, generally more mineralized than water from Dexter member. Water in some areas highly mineralized.
		Dexter member	0-110	Crossbedded ferruginous fine-grained sandstone, clay, and sandy clay.	do	Important source of water for domestic supplies in eastern Tarrant County. Water typically is high in iron.
		Unconformity				
	Comanche series Washita group	Grayson shale	0- 85	Yellowish-brown and grayish-blue fossiliferous marl, clay, and thin limestone.	Slope, generally covered with wash from the Woodbine formation.	Not known to yield water to wells in Tarrant County.
		Main Street limestone	0- 45	Hard white limestone and marl.	Conspicuous and extensive upland prairie, westward facing escarpment.	Do.
		Pawpaw formation	0- 40	Reddish-brown shale charactegized by dwarfed pyrite fossils.	Narrow treeless slope separating terraces on Weno and Main Street formations.	Do.
		Weno clay	0- 75	Bluish-gray marl and limestone, fossiliferous.	Terrace topography produced by limestones of middle and upper parts of the Weno.	Do.
		Denton clay	0- 35	Blue-gray marl, marly ledges, shell agglomerate in upper part.	Grassy slope between resistant Fort Worth and Weno formations.	Do.
		Fort Worth limestone	0- 35	Alternating limestone and marl, fossiliferous.	Upland prairie and black-land soils.	Do.
		Duck Creek formation	0- 90	Impure limestone and marl, which is blue when fresh and straw-colored when weathered. Fossiliferous with distinctive ammonites.	Bench topography produced by lower limestone unit. Upper marl forms slope separating the Duck Creek from Fort Worth limestone.	Do.
		Unconformity				
	Fredericksburg group	Kiamichi formation	0- 40	Blue and brownish - yellow marl, thin limestone and sandstone flags.	Grassy slope separating scarps of Goodland and Duck Creek formations.	Do.
		Goodland limestone	0-130	Chalky-white, fossiliferous limestone, and blue to yellowish brown marl.	Prominent glaring-white escarpment along streams.	Do.

TABLE 5-1. GEOLOGIC FORMATIONS IN TARRANT COUNTY, TEXAS (CONCLUDED).

System	Series and group	Formation and member	Thickness (feet)	Character of rocks	Topographic expression	Water-bearing properties
Cretaceous	Fredericksburg group	Walnut clay	0- 28	Shell agglomerate fossiliferous clay and limestone, sandy clay, and black shale.	Forms conspucuous escarpment and waterfalls in western Cross Timbers belt.	Not know to yield water to wells in Tarrant County.
		Unconformity				
	Comanche series Trinity group	Paluxy sand	140-190	Fine-grained sand, shale, sandy shale, lignite, and pyrite.	Sandy soil, hummocky topography, heavily wooded with oaks.	Source of supply for most households, smaller cities, and some industries.
		Glen Rose limestone	250-450	Fine-grained limestone, shale, marl, and sandstone.	Not exposed in Tarrant County.	Sands yield small supplies to wells in Fort Worth and western Tarrant County. Water too highly mineralized east of Fort Worth.
		Travis Peak formation	250-430	Coarse to fine-grained sandstone, red shale, red and yellow clay at base.	do	Principal aquifer in Tarrant County. Yields large supplies for municipal and industrial purposes. Water in upper sands east of Fort Worth may be highly mineralized.
		Major unconformity				
Pennsylvanian	Undifferentiated		6,000-7,000	Gray, sandy shale, tight quartzitic sandstone, black limestone. Probably represents Strawn formation.	do	Not tested. Probably would not yield fresh water.

SOURCE: LEGGAT 1957.

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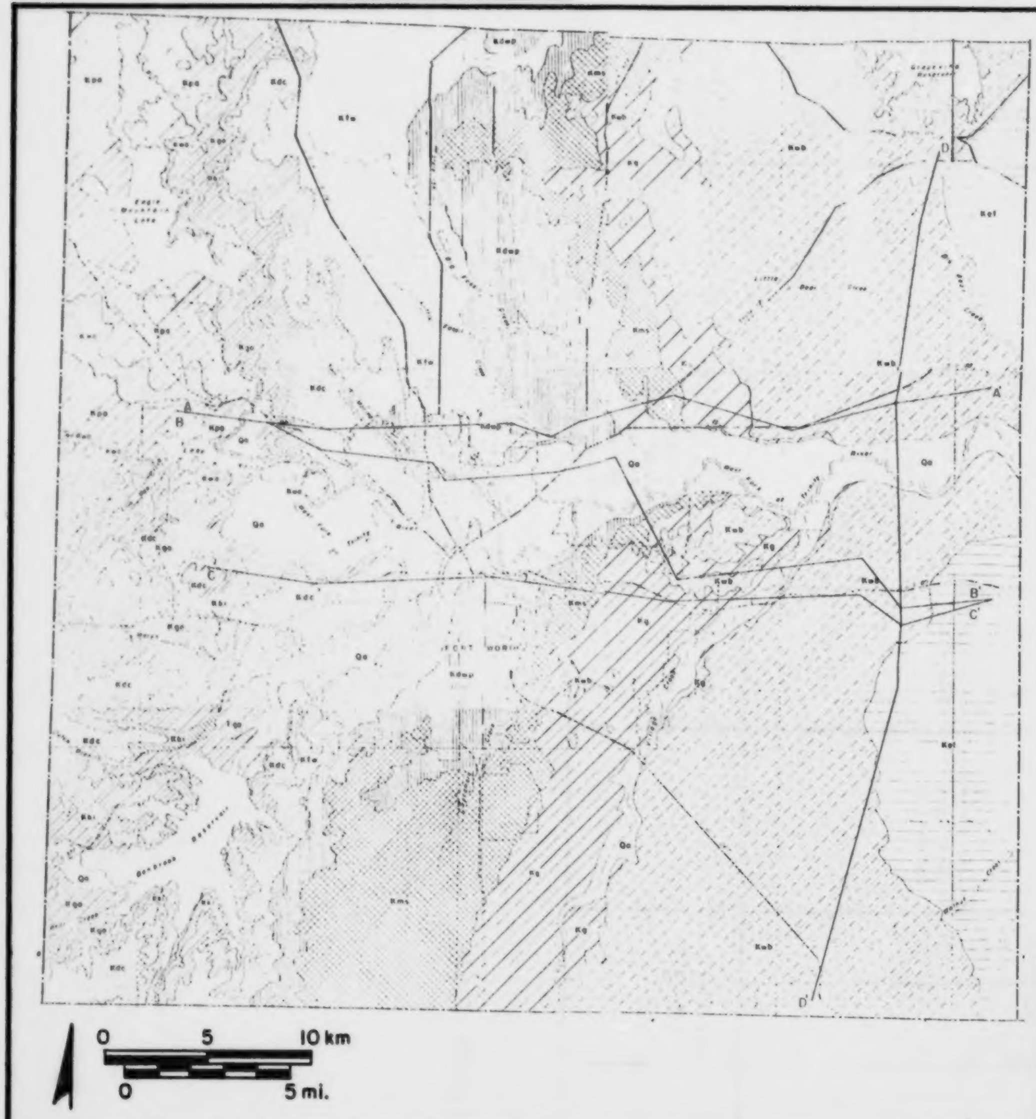
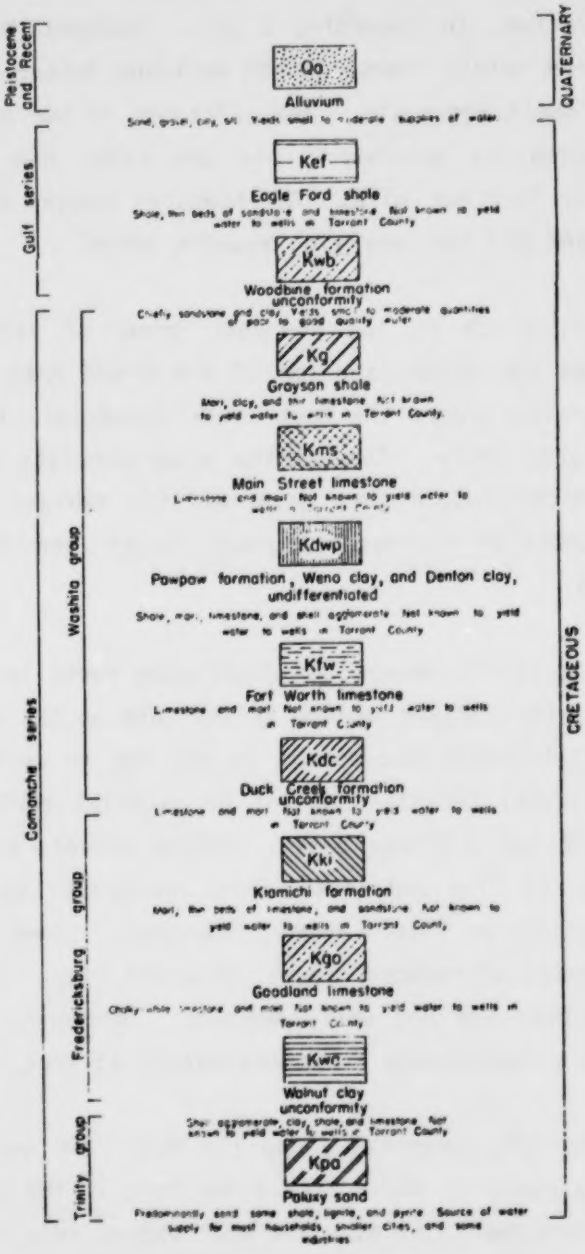


NOTE: SEE FIGURE 5-3 FOR DESCRIPTION (LEGEND) OF OUTCROPS ILLUSTRATED.

FIGURE 5-2. GEOLOGIC MAP SHOWING FORMATION OUTCROPS IN THE PROJECT REGION (SOURCE: ADAPTED FROM LEGGAT 1957).


Pleistocene and Recent
QUATERNARY
Qa
Alluvium
Sand, gravel, clay, silt. Yields small to moderate supplies of water.
Gulf series
Kef
Eagle Ford shale
Shale, thin beds of sandstone and limestone. Not known to yield water to wells in Tarrant County
Kwb
Woodbine formation
unconformity
Chiefly sandstone and clay. Yields small to moderate quantities of poor to good quality water
Kg
Grayson shale
Marl, clay, and thin limestone. Not known to yield water to wells in Tarrant County.
Kms
Main Street limestone
Limestone and marl. Not known to yield water to wells in Tarrant County
Washita group
Comanche series
Kdwp
Pawpaw formation, Weno clay, and Denton clay, undifferentiated
Shale, marl, limestone, and shell agglomerate. Not known to yield water to wells in Tarrant County
CRETACEOUS
Kfw
Fort Worth limestone
Limestone and marl. Not known to yield water to wells in Tarrant County
Kdc
Duck Creek formation
unconformity
Limestone and marl. Not known to yield water to wells in Tarrant County
Fredericksburg group
Kki
Kiamichi formation
Marl, thin beds of limestone, and sandstone. Not known to yield water to wells in Tarrant County
Kgo
Goodland limestone
Chalky white limestone and marl. Not known to yield water to wells in Tarrant County
Kwc
Walnut clay
unconformity
Shell agglomerate, clay, shale, and limestone. Not known to yield water to wells in Tarrant County
Trinity group
Kpa
Paluxy sand
Predominantly sand, some shale, lignite, and pyrite. Source of water supply for most households, smaller cities, and some industries

SOURCE: ADAPTED FROM LEGGAT 1957.

FIGURE 5-3. DESCRIPTION OF GEOLOGIC FORMATIONS OF TARRANT COUNTY AS ILLUSTRATED IN FIGURE 5-2.

The Fredericksburg group includes the Walnut clay, the Goodland limestone and the Kiamichi formation, in ascending order. Sedimentary rocks of the Fredericksburg group are mainly limestone and marl and lesser amounts of sandstone flags, shale and shell aggregate. The thickness of the group ranges from 135 to 185 feet, increasing southward; and the rocks dip southeastward at a uniform rate of 38 feet per mile. The Kiamichi wedges out toward the south between the Goodland and the overlying Washita group.

The Washita group, which is the youngest group of rocks in the Comanche series, constitutes the upland surface of the Grand Prairie belt. The group includes, in ascending order, the Duck Creek formation, the Fort Worth limestone and the Grayson shale. The Washita group consists of alternating limestone and marl which produce the characteristic terrace (or cuesta) topography. The thickness of the Washita group ranges from 318 to 360 feet, decreasing southward.

Detrital alluvial deposits veneer the Cretaceous rocks in the project region, particularly along the incised stream valleys and on the uplands. The alluvium is probably Pleistocene and Recent in age but is undifferentiated on the geologic map. Alluvial deposits consist of material derived from formations that outcrop within the drainage basin. Upland gravels are composed of angular gravel, sand, red clay and silt. Sand and gravel is composed mostly of poorly sorted fragments of flaky layered limestone. Lower terraces and floodplain deposits consist of rounded gravel, sand and clay. Sorting generally is good, and the deposits are not well cemented. Thickness of the alluvial deposits ranges from a featheredge to approximately 45 feet.

Floodplain deposits are extensive along the West Fork and Clear Fork of the Trinity River, and range in width from a few feet in the upper reaches of the stream course to more than 2 miles. The most extensively developed terrace is in the Haltom City and northeast Fort Worth area, where deposits extend a distance of more than 4 miles from the present river channel and as much as 110 feet above it. This extensive deposit probably consists of several terraces formed by the gradual shift southward of the ancestral channel of the West Fork of the Trinity River, but the typical terrace or bench topography has been obscured by erosion and slumping (Leggat 1957).

Economically, limestone, sand and gravel and natural gas are important geological resources in the project region. Additionally, other resources used in the manufacture of cement (a major industry in the area), such as marl and shell conglomerates, are located in the area. Numerous fossils occur throughout formations of the project region.

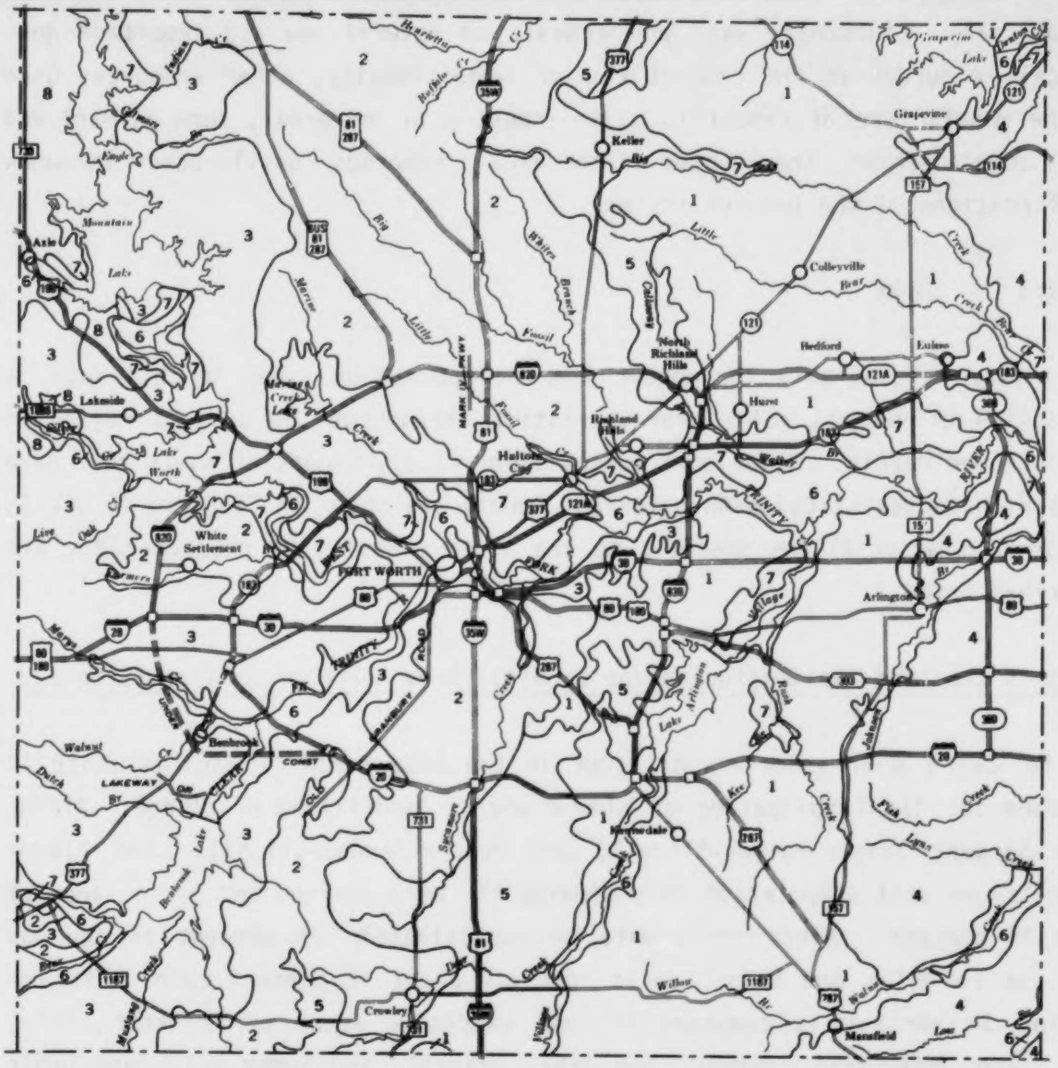
5.1.1.3 Soils

Soils vary considerably throughout the project region. Due to this fact, a discussion of general soils characteristics throughout the project region is not included herein. Major soil associations (i.e., groups of soils that have similar characteristics) within Tarrant County are shown in Figure 5-4. Soils and/or soil associations specific to the three alternative project sites are described below.

Soils of the Land Application and/or Landfill Area North of Saginaw (Site 1).

The following soil associations occur in the area north of Saginaw (Site 1) proposed for land application of sludge and/or landfilling of sludge: Aledo-Bolar-Sanger; Sanger-Purves-Slidell; and Ponder-Sanger-Slidell. The Aledo-Bolar-Sanger soil association is predominantly well drained and has a slope of 1 to 20 percent. Aledo soils make up approximately 38 percent of the map unit, while Bolar and Sanger soils comprise about 12 percent each. The remaining 38 percent is composed of less extensive areas of Brackett, Frio, Luckenbach, Maloterre, Purves, San Saba, Slidell, and Sunev soils and urban land. Aledo and Bolar soils have moderate permeability, with a soil depth of approximately 17 inches and 31 inches respectively. Sanger soils are very slowly permeable with a soil depth of up to 80 inches.

The majority of the sludge disposal target area (Site 1) is located on the Sanger-Purves-Slidell soil association which is predominantly made up of well drained soils that have slopes of 0 to 5 percent. About 28 percent of the unit is Sanger soils, 15 percent Purves soils, 10 percent Slidell soils, and 47 percent less extensive areas of Aledo, Bolar, Frio, Lindale, Mingo, and San



LEGEND

1	**CROSSTELL-GASIL-RADER** Nearly level to sloping, deep, loamy soils; on uplands
2	**SANGER-PURVES-SLIDELL** Nearly level and gently sloping, deep and shallow, clayey soils; on uplands
3	**ALEDO-BOLAR-SANGER** Gently sloping to moderately steep, very shallow to deep, loamy and clayey soils; on uplands
4	**HOUSTON BLACK-NAVO-HEIDEN** Gently sloping, deep, clayey and loamy soils; on uplands
5	**PONDER-SANGER-SLIDELL** Nearly level and gently sloping, deep, loamy and clayey soils; on uplands
6	**FRIO-TRINITY** Nearly level, deep, clayey soils, on flood plains
7	**BASTSIL-SILAWA** Nearly level to sloping, deep, loamy soils, on stream terraces
8	**WINDTHORST-WEATHERFORD-NIMROD** Gently sloping and sloping, deep, loamy and sandy soils, on uplands

*Unless otherwise indicated, the texture given in these descriptive headings refers to the surface layer of major soils.

Compiled 1980

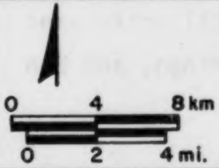


FIGURE 5-4. MAJOR SOIL ASSOCIATIONS IN THE PROJECT REGION (SOURCE: USDA/SCS 1981).

Saba soils and urban land. Permeability is very slow for the Sanger and Slidell soils and both have a soil depth of approximately 80 inches. Moderately slow permeability is typical of the Purves soils, which are approximately 15 inches deep.

The Ponder soils of the Ponder-Sanger-Slidell map unit are moderately well drained with low permeability and are approximately 80 inches deep. The Sanger and Slidell soils are well drained, slowly permeable, and also approximately 80 inches deep.

Prime farmland soils (based on SCS criteria) occur in all three of the soil associations found on the land application/landfill site north of Saginaw (Site 1). The site is too large to show graphically the exact location of these prime farmland soils, as they are sparse and scattered throughout the site.

Soils of the Village Creek WWTF Site (Site 2). Soils in the vicinity of the Village Creek WWTF (Site 2) belong to the Ovan-Urban land complex. Soil characteristics which are important include shrink-swell potential, erosion factor K, wind erodibility group, slope, and corrosiveness.

Ovan soils have a high shrink-swell potential, which is the potential for volume change in a soil with a loss or gain in moisture. The shrinking and swelling of soils can cause damage to buildings, roads, and other structures. Erosion factor K indicates susceptibility of a soil to sheet and rill erosion by water. Values of K range from 0.05 to 0.69, with the Ovan soils of the Village Creek WWTF site rated 0.32. The higher the value the more susceptible the soil is to sheet and rill erosion by water. Soils at Site 2 are moderately erodible, when subjected to flowing water (e.g., rainfall or pipeline breaks). Wind erodibility groups are based on the susceptibility of soil to wind erosion and the amount of soil lost. The Ovan-Urban land complex is classified as wind erodibility group 4, which indicates that these soils also are moderately erodible due to wind action. Revegetation of a disturbed area is most successful if measures to control wind erosion are used (USDA/SCS 1981). The slope of Site 2 is nearly level, as would be expected since it is located on the floodplain of the Trinity River. A level site reduces erosion difficulties associated with development. Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. Ovan soils are highly corrosive for uncoated steel and have a low corrosivity for concrete (USDA/SCS 1981).

Trinity clay and Arents soils predominate in the floodplain across the river from the Village Creek WWTF. Both of these soils are typically found in areas which are frequently flooded. A majority of the area across the river at Site 2 consists of Trinity clay.

Typically, Trinity clay soil is a moderately alkaline, dark gray clay which extends to a depth of 63 inches. It is somewhat poorly drained, and the soil permeability typically is very low (i.e., less than 0.6 in/hr). The clay's erosion factor (K) is 0.32, and the soil is classified under wind erodibility group 4, indicating that it is moderately erodible. Trinity clay soils also have a high shrink-swell potential. When the soil is dry, deep, wide cracks form at the surface. Runoff is very slow, and water ponds on the surface for a few hours following rains. Slopes range from 0 to 1 percent (USDA/SCS 1981).

Arents soils are composed of overburden from gravel and sand mining operations located on nearly level floodplains of large streams. Arents soil consists mainly of loamy fine sands which are moderately alkaline and calcareous. Arents soils have a permeability less than 20 in/hr., and a water capacity range from 0.07-0.12 in//in. The soil has a very low shrink-swell potential, an erosion factor (K) of 0.17, and is classified under wind erodibility group 2 which indicates these soils are very highly erodible. Slopes range from 0 to 1 percent (USDA/SCS, 1981).

Soils of the Mustang Creek Land Treatment Site (Site 3). Although a soil survey has not been published for Johnson County, information on specific soils which occur on the Mustang Creek site is available from the district Soil Conservation Service office. Physical and chemical characteristics of major soils in this area are presented in Table 5-2. The most frequently occurring soils are the Sanger, Bolar, Aledo-Bolar, and Lindale soils.

TABLE 5-2. SOIL CHARACTERISTICS OF THE MUSTANG CREEK LAND TREATMENT SITE.

								Limitations			
Soil	Depth^a in	Clay 2mm %	Perme-ability in/hr	Available Water Capacity in/in	Soil Reaction pH	Erosion Factor K	Organic Matter %	Sewage Lagoon Areas	Embankment Dikes, and Levees	Features Affecting Irrigation	Approximate Cation Exchange Capacity (whole soil) meg/100g
Purves	0-12	35-55	0.2-0.6	0.12-0.18	7.9-8.4	.32	1-3	severe-depth to rock	severe-thin layer	rooting depth; slow intake	20-40
	12-14	35-55	0.2-0.6	0.08-0.18	7.9-8.4	.32	NA				
	14-20	NA	NA	NA	NA		NA				
Bolar	0-16	25-40	0.6-2.0	0.11-0.20	7.9-8.4	.32	1-3	1-7% slope: severe-depth to rock; 7+% slope: severe-depth to rock	moderate-thin layer	1-6% slope: rooting depth 6+% slope: slope, rooting depth	15-30
	16-36	25-40	0.6-2.0	0.11-0.20	7.9-8.4	.17	NA				
	36-44	NA	NA	NA	NA	NA					
Lewisville	0-16	28-45	0.6-2.0	0.16-0.20	7.9-8.4	.32	1-3	0-2% slope: moderate-see page 2- 7% slope: moderate, slope 7+% slope: severe	moderate-hard to pack	differs with texture	20-30
	16-34	30-45	0.6-2.0	0.14-0.18	7.9-8.4	.37	NA				
	34-62	30-50	0.6-2.0	0.14-0.18	7.9-8.4	.37	NA				
Lindale	0-6	NA	0.20-0.6	0.12-0.20	6.1-8.4	.32	NA	1-2% slope: moderate-small stones 2-5% slope: moderate-small stones	moderate-low strength	slow intake	20-35
	6-32	NA	0.06-0.2	0.10-0.20	6.1-8.4	.32	NA				
	32-43	NA	0.06-0.2	0.20-0.10	7.9-8.4	.28	NA				
	43-65	NA	0.06-0.2	0.06-0.15	7.9-8.4	.28	NA				

TABLE 5-2. SOIL CHARACTERISTICS OF THE MUSTANG CREEK LAND TREATMENT SITE (CONTINUED).

Soil	Depth[a] in	Clay 2mm %	Perme-ability in/hr	Available Water Capacity in/in	Soil Reaction pH	Erosion Factor K	Organic Matter %	Limitations		Features Affecting Irrigation	Approximate Cation Exchange Capacity (whole soil) meg/100g
								Sewage Lagoon Areas	Embankment Dikes, and Levees		
Slidell	0-19	40-60	0.05	0.15-0.20	7.4-8.4	.32	1-4	0-2% slope: slight 2-5% slope: moderate-	moderate-hard to pack	slow intake percolates slowly	40-55
	19-78	40-60	0.06	0.15-0.20	7.4-8.4	.32	NA				
Krum	0-6	35-55	0.2-0.6	0.15-0.20	7.4-8.4	.32	1-3	0-2% slope: slight 2-7% slope: moderate- 7-8% slope: severe-	moderate-hard to pack	slow intake, slope	30-50
	6-44	40-60	0.2-0.6	0.14-0.20	7.9-8.4	.32	0.5-2				
	44-72	35-60	0.2-0.6	0.14-0.20	7.9-8.4	.32	.5				
Frio	0-40	35-50	0.2-0.6	0.15-0.22	7.9-8.4	.32	1-4	slight	moderate-hard to pack	floods	20-35
	40-62	35-50	0.2-0.6	0.11-0.22	7.9-8.4	.32	NA				
Sanger	0-36	40-60	0.06	0.12-0.18	7.4-8.4	.32	1-3	1-2% slope: slight 2-7% slope: moderate- 7+% slope: severe-	moderate-hard to pack	1-6%: slow intake, percolates slowly; 6+%: slow intake, slope, percolates slowly	40-55
	36-55	40-60	0.06	0.12-0.18	7.9-8.4	.32	NA				
	55-90	40-60	0.06	0.12-0.18	7.9-8.4	.32	NA				

TABLE 5-2. SOIL CHARACTERISTICS OF THE MUSTANG CREEK LAND TREATMENT SITE (CONCLUDED).

Soil	Depth[a] in	Clay 2mm %	Permeability in/hr	Available Water Capacity in/in	Soil Reaction pH	Erosion Factor K	Organic Matter %	Limitations: Sewage Lagoon Areas	Limitations: Embankment Dikes, and Levees	Features Affecting Irrigation	Approximate Cation Exchange Capacity (whole soil) meg/100g
Aledo	0-4	20-35	0.6-2.0	0.07-0.18	7.9-8.4	.32	NA	1-7% slope: severe, depth to rock, small stones 7+% slope: severe-slope depth to rock, small stones	severe-thin layer droughty, slope	rooting depth,	20-30
	4-16	20-35	0.6-2.0	0.05-0.12	7.9-8.4	.10	NA				
	16-20	NA	NA	NA	NA	NA	NA				
Hensley	0-4	15-30	0.2-0.6	0.12-0.20	6.1-7.8	.37	0.5-2	severe-depth to rock	severe-thin layer	soil blowing, percolates slowly, depth to rock	20-30
	4-16	35-55	0.06-0.02	0.10-0.20	6.6-8.4	.32	NA				
	16-20	NA	NA	NA	NA	NA	NA				

NA: not available
--: not applicable

a. Depth to high groundwater for all soils is >6 ft.

SOURCE: BALLARD 1982 AND BLAKLEY 1982.

Prime farmland soils (based on SCS criteria) include the following soils with a 1 to 3 percent slope: Bolar, Lewisville, Lindale, Slidell, Krum, Frio, and Sanger. A reproducible graphic illustrating the location of prime farmlands on this site currently is not available. Prime farmland soils are located throughout the Mustang Creek irrigation site (Site 3), and comprise an estimated 20 percent (i.e., approximately 1,700 acres) of the total land area of Site 3.

5.1.2 Environmental Consequences of the No Action Alternative

5.1.2.1 Topography

If no action is taken, the topography of the project region and of the specific alternative sites would remain unchanged.

5.1.2.2 Geology

If no action is taken, the geology of the project region and the individual alternative sites would remain unchanged.

5.1.2.3 Soils

If no action is taken, two situations potentially would occur that could affect soils: (1) sewage collection lines would overflow; and (2) excess, undigested sludge that could not be dried on existing sludge drying beds would be disposed potentially by landfilling and/or surface landspreading in other areas. Sewage overflowing existing collection lines potentially would either run down streets and through storm sewers to creeks and other natural drainage channels, or would run in sheet flow across natural ground toward creeks and drainage ways. Raw sewage running across the ground could result in an increase in levels of organic solids, inorganic solids and heavy metals in the surface soils. These increases, however, would be small. Leachate from undigested sludge spread or stockpiled on the surface also potentially would contaminate soils. However, since the location at which overflows and landfilling or landspreading operations would occur as a result of taking no action currently cannot be determined, site-specific effects on soils due to overflows and sludge disposal practices cannot be identified.

5.1.3 Environmental Consequences of Alternative 1

5.1.3.1 Topography

Sludge Disposal Site (Site 1). The site for a sludge storage pile would be leveled, graded and paved with a slight slope to allow for surface runoff into an evaporation pond. This slight alteration to topography would be minor.

If this alternative is chosen, sludge will be applied to land which currently is being used for crop production. Therefore, there will be no need for any major topographic alteration prior to landspreading sludge.

Village Creek Site (Site 2). When the Village Creek WWTF was constructed, 152 acres of land were diked and cleared. The existing plant occupies approximately 80 percent of this space. The proposed expansion would be constructed on approximately 15 acres of land that already has been cleared and graded for development; therefore, no further major impacts to the topography of the area would occur.

5.1.3.2 Geology

Sludge Disposal Site (Site 1). No effect on the geology of the sludge disposal site would occur as a result of this alternative, since stockpiling and landspreading are surface activities.

Village Creek Site (Site 2). No effect on the geology of the Village Creek site would occur as a result of this alternative, since all proposed activity is surface oriented.

5.1.3.3 Soils

Sludge Disposal Site (Site 1). The site for the proposed sludge storage pile would be paved, thereby reducing the potential for negative impact to soils at this site due to toxic build-up from leachates.

Alternative 1 proposes to use sludge as a soil conditioner for privately owned agricultural land. Sewage sludge contains stable humus-like organic compounds which resist decomposition. These molecules, when well incorporated into soil, tend to bring about changes in soil structure which have long-term beneficial effects upon physical properties of the soil. The importance of organic matter to soil conditioning has long been recognized by farmers who have been applying barnyard manures, compost, and other organic wastes to soils (USEPA 1981a).

The principal change occurring as a consequence of adding organic matter to soil is the gradual formation of a loose, friable soil structure. Epstein (1975) found a doubling of the percent of stable aggregates in a soil amended with sludge over a period of 175 days. Organic matter increases the water-holding capacity of the soil; organic soils can retain more than their own weight of water against gravity drainage, while a sandy loam soil may hold less than ten percent water. Thus, successive applications of sludge over several years slowly builds up the water-holding capacity of soil (USEPA 1981a).

The improved soil structure enhances root penetration and vigorous growth throughout the soil profile, leading to generally healthier, more vigorous plant growth and increased crop production (USEPA 1981a). In addition to increasing crop production, there also is some nutrative value in sludge. However, concentrations of nutrients that increase soil fertility (nitrogen, phosphorous, and potassium) are considerably lower in sludge than in commercial fertilizers, therefore sludge typically is considered a soil conditioner rather than a fertilizer.

Forming stable aggregates, as discussed above, also helps increase soil resistance to both wind and water erosion. Additions of sludge over a number of years gradually reduces soil erodibility, and thus provides a self-correcting mechanism against contamination of surface waters in addition to conserving topsoil. Many soils in Site 1 naturally are moderately erodible in the absence of plant cover. Over the years, sludge applications can significantly reduce soil erodibility in these areas (USEPA 1981a).

Physical conditioning as described above is more apparent with high rates of sludge application. Application rates for this project would be low (2.6 tons per acre per year), and therefore physical conditioning effects would be limited in the short-term.

With application of sewage sludge to soils, there in general is a possibility of build-up of toxic metals. Primary factors controlling the build-up and uptake by plants of certain toxic metals are the amount of the metals in the sludge, the pH of the soil, and the sludge application rate (USEPA 1981b). A review of the sludge analyses included in Appendix B indicates that sludge currently generated at the Village Creek WWTF does not have high concentrations of heavy metals, therefore lessening the probability of toxic build-ups of heavy metals in the soil and in crops grown on this soil. Lifetime concentrations of metals in soils would be maintained at or below limits established by EPA.

Experiments have shown that concentrations of metals in plant tissue decrease with increasing soil pH (USEPA 1981b). The pH of soils in the target area are generally within the mildly to moderately alkaline range (pH 7.4 to 8.4). It is expected that the alkaline nature of the soils would help reduce any negative impacts resulting from application of sludge to agricultural land.

As was stated previously, the sludge application rate proposed for Alternative 1 would be low (approximately 2.6 tons per acre per year). This fact in combination with relatively low concentrations of metals in the sludge and the alkaline nature of the soils indicates that the probability of toxic metal build-up in the soils and crops of the land application area would be low. It also should be noted that the soils of the area have relatively high cation exchange capacities (Blakley 1982), thereby further reducing the potential of a significant adverse impact due to sludge application (i.e., landspreading). Due to beneficial properties of sludge as previously discussed, landspreading sludge in Site 1 would not adversely affect soil characteristics of prime farmland soils. However, prime farmland soils in Site 1 would not be used for production of food-chain crops during the 20-year planning period (1985-2005).

Village Creek Site (Site 2). No significant effect on the soils of Village Creek site is expected as a result of this alternative. The soils of the Village Creek Site are moderately erodible and an increased erosion potential would exist during construction. Prompt revegetation of exposed areas after construction would reduce erosion.

5.1.4 Environmental Effects of Alternative 2A

5.1.4.1 Topography

Sludge Disposal Site (Site 1). The exact location of a municipal refuse landfill currently has not been chosen by the City Department of Public Works, Sanitation Division. A municipal landfill to be utilized for co-disposal (i.e., sludge plus municipal refuse) would comprise approximately 1,270 acres of the 60,000 acre target zone (Site 1).

Construction of a landfill would require excavation, construction of berms, and other activities which would affect local topography. However, the landfill potentially would exist regardless of whether or not it is used for sludge disposal; therefore, major topographic impacts would not result solely due to the proposed sludge disposal.

Village Creek Site (Site 2). As was described in Section 5.2.3.1, no major effect to the topography of this area is expected due to the proposed expansion of the Village Creek WWTF.

5.1.4.2 Geology

Sludge Disposal Site (Site 1). No substantial effect on the geology of the landfill site within the 60,000 acre target zone is expected as the result of sludge disposal in a municipal landfill.

Village Creek Site (Site 2). No effect on the geology of the Village Creek site is expected as a result of Alternative 2A.

5.1.4.3 Soils

Sludge Disposal Site (Site 1). Landfill construction and operation must follow regulations established by the Texas Department of Health. The municipal landfill would be lined with clay or plastic membrane which would minimize the potential for adverse impacts of sludge and refuse leachates on the soil. Sludge would comprise from 10 to 30 percent of the material disposed at the landfill; therefore, potential effects on the soils directly attributable to sludge disposal would be very small.

Village Creek Site (Site 2). No major effect on soils at the Village Creek WWTF site is expected as a result of this alternative. The soils of the Village Creek site are moderately erodible, thus, an increased erosion potential would exist during construction. Prompt revegetation of exposed areas after construction would reduce erosion.

5.1.5 Environmental Consequences of Alternative 2B

5.1.5.1 Topography

Sludge Disposal Site (Site 2) The topography of the proposed 500-acre sludge disposal site is flat to very gentle. Construction of a landfill would raise surface elevations approximately 15 ft. The proposed flood channels would require excavation which also would alter local topography. Alterations to drainage patterns in this area would occur due to construction of the landfill and proposed flood channels.

Village Creek Site (Site 2). Expansion of the Villate Creek WWTF would have no major adverse or beneficial effect on the topography of Site 2, because the expansion would be confined to the boundaries of the existing plant.

5.1.5.1 Geology

Sludge Disposal Site (Site 2). No substantial effect is expected on the geology of the 500-acre sludge landfill site if Alternative 2B is implemented because all improvements are surface and near-surface oriented.

Village Creek Site (Site 2). No adverse effect on the geology of the Village Creek WWTF area is anticipated due to implementation of Alternative 2B, because all improvements would be confined to surface and near-surface strata.

5.1.5.3 Soils

Sludge Disposal Site (Site 2). The 500-acre sludge disposal site would include areas for proposed sludge storage and dewatering facilities, proposed flood channels, the proposed landfill, and land identified for beneficial reuse of sludge. Most construction would take place in an area containing Trinity clay soils. Major impacts related to soil would be associated with construction of the new landfill and the proposed flood channel. The high shrink-swell properties of the Trinity clay soils could cause structural problems at the dewatering facilities. The moderately high erosion factor indicates that erosion would occur when the site is denuded during construction operations. With proper control measures, sediment derived from erosion would not cause major increased turbidity in the West Fork of the Trinity River.

Village Creek Site (Site 2). Soils at the Village Creek WWTF consist of Ovan-Urban land complex soils which contain about 40 to 85 percent Ovan soil, 15 to 40 percent Urban land soil, and less than 15 percent other closely similar soils. This complex is moderately well drained and exhibits moderate erosion potential. No major adverse soils impacts are expected as a result of the expansion of the Village Creek WWTF. A small amount of erosion and sedimentation would occur during construction, but effects of the erosion would be minimal.

5.1.6 Environmental Effects of Alternative 3

5.1.6.1 Topography

Sludge Disposal Site (Site 1). Sludge would be applied to land that already is being used for crop production; therefore, no further topographic alterations would be necessary.

Pipeline Route. There will be no significant alteration to the topography of the pipeline route resulting from this alternative.

Mustang Creek Land Treatment Site (Site 3). Construction of the 75-acre aerated lagoon, 450-acre storage reservoir and 75-acre buffer zone would require leveling, berm construction, grading, excavation, and other construction activities. Although these topographic alterations would be major changes to the specific site, they would not constitute a major affect on topography of the project region.

Wastewater would be used to irrigate land that already is being used for crop production, therefore no further topographic alterations for irrigation or crop production would be necessary.

5.1.6.2 Geology

Sludge Disposal Site (Site 1). Land application of sludge would not affect the geology of this area since landspreading is a surface operation.

Pipeline Route. Construction and operation of the pipeline would consist of near-surface operations and thus would not affect the geology of the area.

Mustang Creek Land Treatment Site (Site 3). Land treatment of wastewater would not affect the geology of the area, since all operations would be surface operations.

5.1.6.3 Soils

Sludge Disposal Site (Site 1). Effects on soils of the sludge disposal site would be the same as those described in Section 5.1.3.3; however, there would be a smaller area of soils affected (i.e., 15,000 ac instead of 22,000).

Pipeline Route. Pipeline construction would not have a major adverse affect on soils along the pipeline route. Minor erosion and mixing of topsoil layers would occur.

Mustang Creek Land Treatment Site (Site 3). Short-term soil impacts resulting from this alternative would include erosion, compaction, and soil disturbance. Construction of the aerated lagoon and storage reservoir would denude those areas of vegetation, therefore rendering them more susceptible to wind and water erosion. Prompt revegetation of the exposed areas would reduce the erosion potential. Soil compaction would result from construction activities and associated traffic. Soil disturbance also would accompany the construction of the aerated lagoon and storage reservoir, as well as the installation of underdrains in areas with shallow soils. Large quantities of spoil would be generated during construction of the aerated lagoons and storage reservoir. It is expected that topsoil would be removed and used to aid in revegetation and the remaining spoil would potentially be used for dam (i.e., storage reservoir) construction.

If this alternative is chosen, a detailed soil survey and analysis of the specific site would be necessary. A preliminary evaluation indicates that the soils of the Mustang Creek area are relatively well suited for irrigation with wastewater effluent. The following characteristics are particularly important for determining soil suitability for wastewater treatment through slow rate irrigation: slope, cation exchange capacity (CEC), permeability, depth of soil, texture, and pH.

The slope of the Mustang Creek site is generally between 1 and 3 percent with isolated areas of up to 8 percent. Slow-rate irrigation requires a slope of less than 20 percent (USEPA 1977).

Cation exchange capacity (CEC) is a measure of the ability of a soil to retain cations. Indirectly, however, CEC serves as a rough index of all reactions which occur between charged pollutants and colloidal surfaces. In general, the greater the CEC of a particular soil, the greater the potential for effective waste treatment. The CEC of the soils in the Mustang Creek area area relatively high (refer to Table 5-2) and therefore have a high potential for wastewater detoxification. A CEC between 13 and 27 meg/100 g is considered necessary for slow rate irrigation of wastewater. All soils in the project area fall within or exceed this range (USEPA no date).

Soils of the Mustang Creek area have very slow to moderate permeability. The ideal permeability for slow rate irrigation is moderately slow to moderately rapid, and the majority of the soils in Site 3 fall within this permeability range.

Some of the soils in Site 3, including one of the four frequently occurring soils (Aledo), are classified as shallow. One of the major problems with slow rate irrigation in shallow soils is the potential for ponding and possible surface runoff of wastewater. If this alternative is chosen, underdrains would be placed where necessary to alleviate problems associated with shallow soils.

Soil texture refers to the coarseness or fineness of individual mineral particles. By definition, sandy soils are those in which sand makes up 70 percent or more of the material by weight. A clayey soil must contain at least 35 percent clay. Between these extremes, loamy soils contain variable mixtures of sand, silt, and clay. Soils of the Mustang Creek area are primarily clay loam soils with a moderately fine texture. The ideal soil texture for slow rate irrigation with wastewater ranges from clay loams to sandy loams; therefore, the texture of soils in Site 3 are well suited for slow rate irrigation (USEPA 1977).

The pH of soil is an important characteristic which affects the treatment capability of the soil. Soils of the Mustang Creek area are mildly to moderately alkaline, with the majority of soils having a pH between 7.4 and 8.4. Generally, there is a direct relationship between pH and the capacity of a soil to retain metals; alkaline soils are better for wastewater detoxification than acidic soils.

Irrigation with municipal sewage effluent has the potential for both positive and negative effects on soils of the Mustang Creek area. Application of sewage effluent increases the carbon content of the soil, resulting in increased aggregation, decreased bulk density, increased water holding capacity and hydraulic conductivity. Furthermore, organic matter and soil aggregation are inversely related to runoff volumes and sediment loss. Liquid wastes (sewage effluent) generally have a lower organic carbon content compared to solid wastes (sewage sludge); hence, the positive effects mentioned above are lower for liquid waste than for solid waste (Khaleel et al. 1981). Evidence from two sites where wastewater has been applied annually on land for more than 35 years (Bakersfield, California and Lubbock, Texas) indicate that crop production has been increased by use of municipal sewage effluent for irrigation over that obtained with other sources of water and commercial fertilizer on neighboring farms. Increased production has been realized in spite of frequent periods of hydraulic overloading with effluent (USEPA 1976d).

The possibility exists for a toxic build-up of nutrients (primarily nitrogen and phosphorous) or heavy metals due to irrigation with wastewater effluents. Nitrogen removal from applied wastewater occurs through crop uptake, growth of microbial cells, volatilization of ammonia, conversion to nonbiodegradable organic matter, and denitrification. The first few years after a land application system is initiated, the microbial population may increase dramatically and result in increased nitrogen storage in the soil profile. Nonbiodegradable organic matter containing nitrogen accumulates in a similar manner until a new steady-state condition is reached. Once a steady-state condition is reached (5-10 years) there will be no further nitrogen removal by the soil through growth of aerobic microbes and conversion to nonbiodegradable organic matter (USEPA 1976d).

All nitrogen, regardless of form when applied, is eventually mineralized to the nitrate form unless lost by volatilization. Nitrogen in the nitrate form is very mobile and subject to movement through soil into groundwater unless it is removed through plant uptake and to a much lesser extent, denitrification. The land application rate of nitrogen for this alternative is 295 pounds per acre per year. It is expected that most farmers will grow bermuda grass which has a nitrogen uptake of 480-600 pounds per acre per year; therefore, there would not be a problem with nitrogen build-up in the soils.

Phosphorus is removed by crops, precipitation, and adsorption by soil colloids. Removal of phosphorus is, therefore, dependent on soil texture, cation exchange capacity, soil pH, presence of calcium, amount of iron and aluminum oxides present, and uptake of phosphorus by the crop. Because of these removal mechanisms, there is a large capacity for phosphorus removal, and little movement of phosphorus through the soil profile with drainage water can be expected. Phosphorus removal capacity is finite, and over a long time period or with high loadings, phosphorus additions may exceed the soil's capacity for removal (USEPA 1976d).

Calcareous soils of the Mustang Creek area (Site 3) have a high adsorption capacity for phosphorus (Blakley, 1982). Since wastewater effluent contains relatively low quantities of phosphorus, no build-up should occur. Addition of phosphorus through irrigation with wastewater effluent would benefit crops, and any excess should be adsorbed by the soil.

Negative effects due to heavy metals is a concern whenever wastewater effluent is applied to land. Most heavy metals are effectively removed as water percolates through soil. Mechanisms for removal are adsorption on the exchange complex or with iron, aluminum, and other elements, and precipitation in very insoluble forms.

Table 5-3 compares recommended concentrations of metals in wastewater effluent to be used for irrigation to expected concentrations in the effluent to be used on the Mustang Creek soils. The expected effluent quality is below EPA recommended levels, and for all the metals except cadmuim, it is considerably below recommended values. Effluents which meet these recommended values would normally not adversely affect plants or soils (USEPA 1976d).

The high CEC and the neutral to moderately alkaline soils of the Mustang Creek area have a high capacity for adsorbing heavy metals. These qualities in combination with low metal concentrations in the effluent would significantly reduce problems associated with heavy metals. Some metals and other inorganic chemicals are micro nutrients or trace elements required by plants in small quantities therefore, at low levels they would benefit crops.

Salts are found in all natural waters from weathering of soil and rocks into basic elements. Because irrigation water lost to evaporation and transpiration leaves salts behind, water consumption increased above present levels

Table 5-3. RECOMMENDED MAXIMUM CONCENTRATIONS OF SPECIFIC IONS IN IRRIGATION WATERS[a] (mg/l) VS. EXPECTED CONCENTRATIONS IN ALTERNATIVE 3 EFFLUENT.

		Recommended Maximum Concentration		Expected Level
Element	Mechanism[b]	3 ft/yr[c] appl. rate	8 ft/yr appl. rate	5.4 ft/yr appl. rate
Aluminum	PR, S	20.00	8.00	2.50
Cadmium	AD, CE, S	0.05	0.02	0.03
Chromium	AD, CE, S	1.00	0.40	0.02
Copper	AD, CE, S	5.00	2.00	0.03
Iron	PR, CE, S	20.00	8.00	0.17
Lead	AD, CE, S	10.00	4.00	0.04
Manganese	PR, CE, S	10.00	4.00	0.01
Nickel	AD, CE, S	2.00	0.80	0.06
Zinc	AD, CE, S	10.00	4.00	0.06

a. These levels normally would not adversely affect plants or soils.

b. AD = adsorption with iron or aluminum hydroxide, h dependent; AE = anion exchange; CE = cation exchange; PR = precipitate, pH dependent-iron and manganese are also subject to changes by oxidation reduction reaction; S = strong strength of removal; W = weak strength of removal.

c. EPA Water Quality Criteria, 1972.

SOURCE: ADAPTED FROM USEPA 1976d.

by evapotranspiration would increase total dissolved solid concentrations in the soil. The increase in salt concentration in the soil is a problem with all irrigation regardless of the water source; however, higher levels of salts in wastewater can lead to some potential problems. The main effect of excess sodium is a dispersion of the clay content of soil and consequent reduction in permeability. In one case, a 25 percent reduction of infiltration rates resulted from 14 years of irrigation of agricultural crops by wastewater using irrigation rates recommended for agricultural production (USEPA 1976d). The low irrigation rates proposed for Alternative 3 should minimize salt buildup in soils.

5.2 GROUNDWATER

5.2.1 Existing Conditions

5.2.1.1 Geohydrology

Principal aquifers in the project region are within strata of the Cretaceous system (refer to Table 5-1). Cretaceous rocks lie unconformably on strata of the Pennsylvanian series. Trinity group aquifers form the underlying section of the Cretaceous system. In ascending order, the formations of the Trinity group consists of the Travis Peak formation, Glen Rose limestone, and the Paluxy sand. Remaining Cretaceous group strata in the project region are the Washita and Fredericksburg groups, the Woodbine formation and the Eagle Ford formation.

Sands of the Trinity group, and particularly the Travis Peak formation and Paluxy sand, are the principal sources of groundwater in the project region and at all three alternative project sites. Small quantities of groundwater also are obtained from the Woodbine formation, surface alluvial deposits, and from the Glen Rose limestone in areas west of Fort Worth. A generalized geologic cross-section of the project region is shown in Figure 5-5. The shaded formations in Figure 5-5 are the principal sources of groundwater, whereas the unshaded strata are impermeable formations.

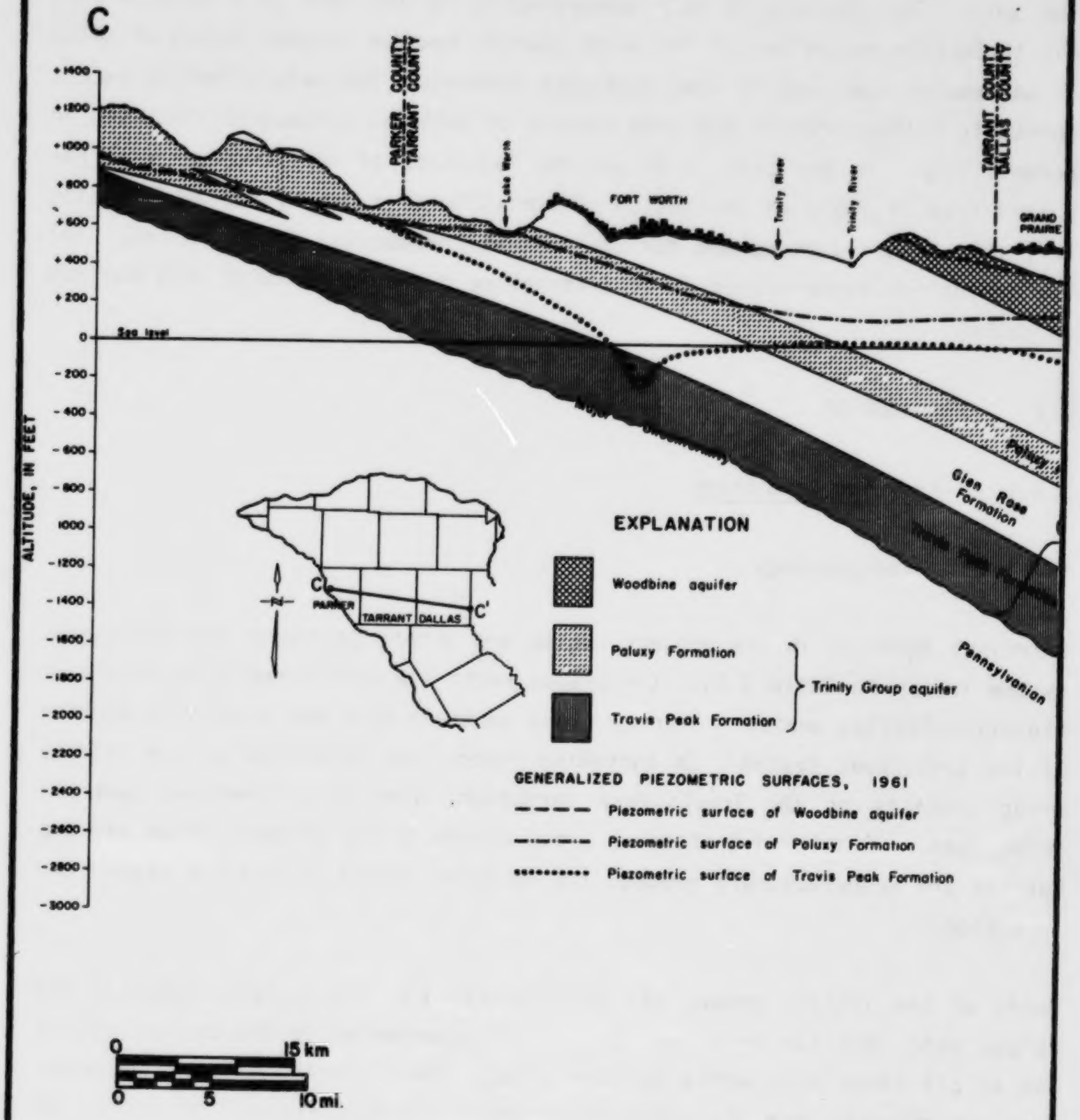


FIGURE 5-5. GENERALIZED CROSS SECTION SHOWING PRINCIPAL AQUIFERS IN THE PROJECT REGION (SOURCE: PECKHAM et al. 1973).

The Paluxy sand formation is formed from fine-grained massive to cross bedded lenticular sand interbedded with clay and sand clay (Peckham et al. 1963). The sand grades both laterally and vertically into finer sediments. The Paluxy sand outcrops (i.e., reaches the surface) in the northwestern part of the project region (refer to Figure 5.5). It forms the surface of the Western Cross Timbers belt and underlies the rest of Tarrant County. The Paluxy dips uniformly east-southeastward, with the dip of the strata becoming progressively steeper in the downdip direction. The Paluxy formation ranges in thickness from 140 to 190 feet and averages about 160 feet in the project region.

The Glen Rose limestone formation normally separates the Paluxy formation and Travis Peak formation. The Glen Rose formation does not outcrop in the project region but is penetrated by wells drilled to the underlying Travis Peak formation. The Glen Rose formation thickens eastward at a rate of about 7 feet per mile (ft/mi) and southward at a rate of about 3 to 4 ft/mi. It ranges in thickness from about 250 to about 450 ft. Composition of the Glen Rose formation is primarily marly limestone, marl and shale with some sand and anhydrite.

The Travis Peak formation contains large quantities of water and is located throughout the project region. It consists mainly of sands, silty clays, and siliceous conglomerates. It also is commonly known as "Lower Trinity Sands". The Travis Peak Formation is not exposed at the surface in the project region and ranges in thickness from 100 to 120 ft.

Groundwater Movement, Recharge, and Discharge

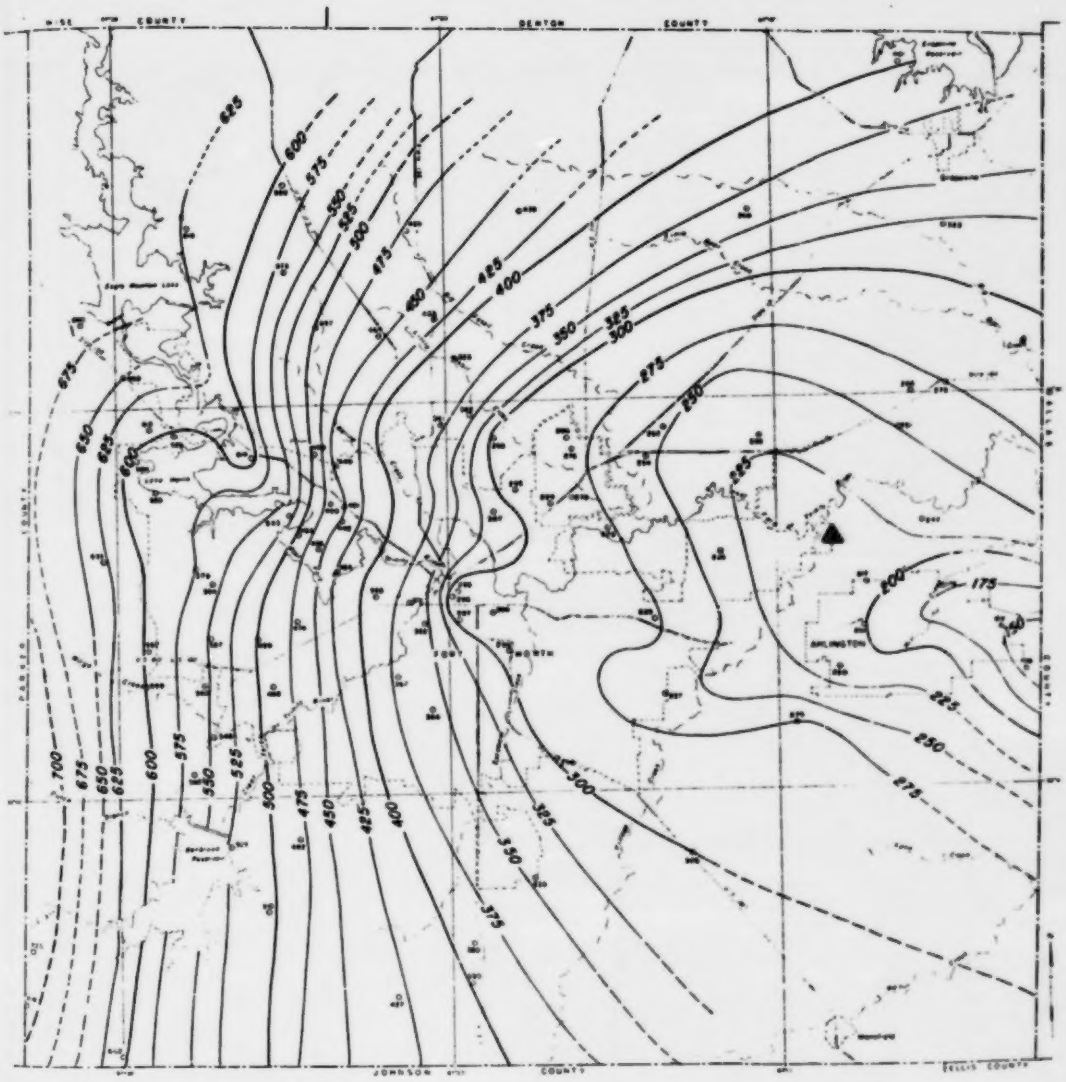
Groundwater occurs under water-table or artesian conditions. Under water-table conditions, water is unconfined and does not rise in wells above the level at which the water is first encountered. Under artesian conditions, water is confined under hydrostatic pressure in the aquifer between relatively impermeable beds. When the elevation of the land surface is below the general level of the outcrop areas, pressure may be sufficient to cause water to rise a considerable distance in a well (Leggat 1957).

In the project region (Tarrant County), water-table conditions exist in the outcrop areas of the Paluxy sand and Woodbine formations, and in scattered Quaternary deposits. Artesian conditions prevail in the Travis Peak formation and Glen Rose limestone throughout the project region and in the Paluxy and Woodbine formations where they are overlain by relatively impervious material southeast of their areas of outcrop (Leggat 1957).

The general direction of movement and hydraulic gradient of water in the Paluxy sand formation is shown by the piezometric surface contour map in Figure 5-6. The piezometric surface is the imaginary surface to which artesian water would rise in tightly cased wells that penetrate the aquifer. The movement, which is at right angles to the contours, generally is toward the east or southeast. However, because of heavy withdrawals of groundwater from the Paluxy sand between Fort Worth and Dallas, the contours do not conform to this general direction, but swing sharply toward Arlington.

Figure 5-7 shows the direction of water movement and slope of the piezometric surface in the Travis Peak formation. The contours again show that water moves toward the center of areas of large or concentrated withdrawal. Sufficient data are not available to show the direction of movement of water in the Woodbine formation; however, the direction of movement probably conforms to the southeastward dip of the sand. Movement of groundwater in alluvial deposits is toward surface streams (Figure 5-8).

Groundwater in the project region is chiefly derived from percolation of rainfall on the outcrop area of the aquifers. Part of the groundwater is derived from streamflow and seepage from lakes. Sandy outcrops of the Travis Peak, Paluxy, and Woodbine formations present excellent opportunities for recharge from precipitation whenever water is available in excess of soil moisture requirements. Recharge from direct infiltration on the outcrop area generally occurs only during periods of heavy rainfall. Most of the groundwater in the Quaternary floodplain and terrace deposits near Haltom City, Richland Hills, and River Oaks is derived from precipitation on the surface of these deposits, although part may be from subsurface leakage from cisterns and water distribution lines.



▲ LOCATION OF VILLAGE CREEK WWTF.

○299 Well used for control-
Number is altitude of water level
Contour interval is 25 feet
Datum is mean sea level

0 5 10 km
0 5 mi.

FIGURE 5-6. GENERALIZED CONTOURS ON THE PIEZOMETRIC SURFACE OF THE PALUXY SAND IN THE PROJECT REGION (SOURCE: LEGGAT 1957).

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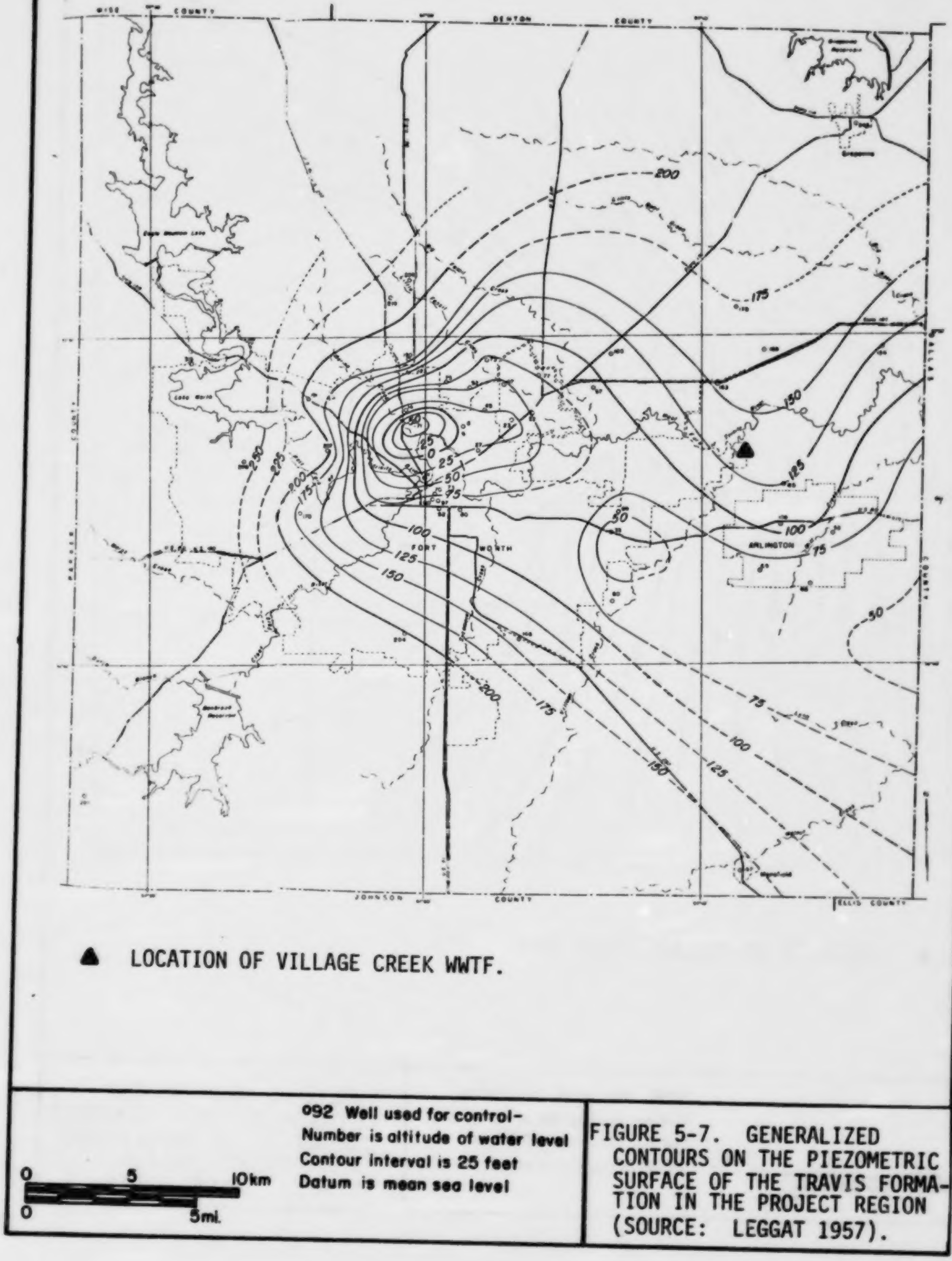
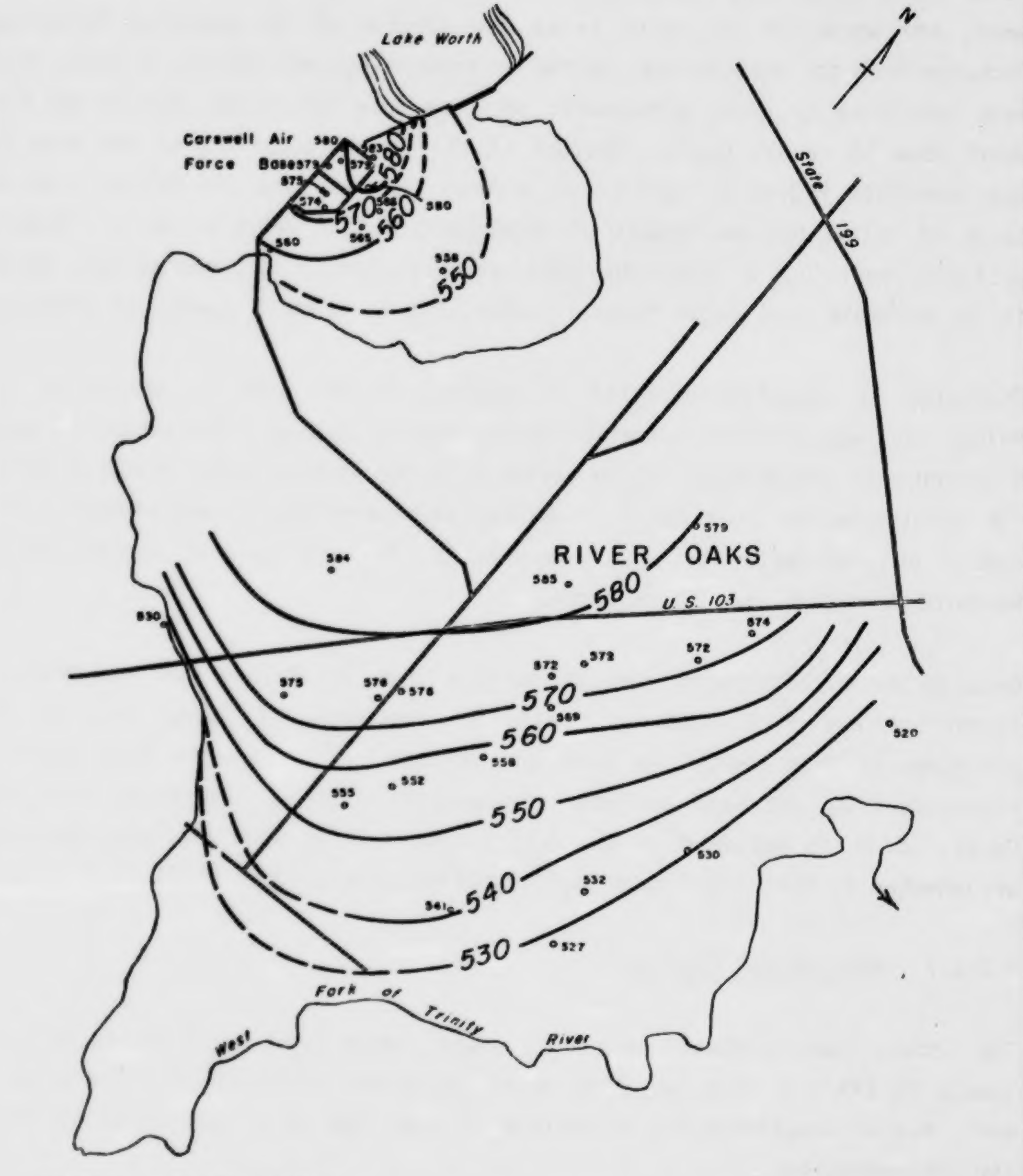


FIGURE 5-7. GENERALIZED CONTOURS ON THE PIEZOMETRIC SURFACE OF THE TRAVIS FORMATION IN THE PROJECT REGION (SOURCE: LEGGAT 1957).



SOURCE: LEGGAT 1957.

o552 Well used for control
Number is altitude of water level
Contour interval is 10 feet
Datum is mean sea level

0 0.5 1 km
0 0.5 mi.

FIGURE 5-8. ILLUSTRATION OF HOW GROUNDWATER IN SHALLOW ALLUVIAL AQUIFERS MOVES TOWARD SURFACE STREAMS.

Lakes in the project region also are a source of recharge to groundwater aquifers. Lake Worth and Eagle Mountain Lake are on the outcrop of the Paluxy sand, and Grapevine Reservoir is on the outcrop of the Woodbine formation. Recharge from the lake to the aquifer is induced by the relatively steep gradient developed by large withdrawals of water from the Paluxy sand in the Fort Worth Area in recent years. Because of the low permeability of the sand and the imperfect hydraulic connection between the lake and the Paluxy sand because of siltation, the amount of recharge from Lake Worth is small. Because geologic conditions at Eagle Mountain Lake are similar to those at Lake Worth, it is probable that Eagle Mountain Lake also is a small source of recharge.

Discharge by evapotranspiration is greatest in the area of outcrop of the Paluxy sand and Woodbine formation in the project region. The amount of water discharged by evapotranspiration varies with the season, being greatest during the growing season from April to October when temperatures are highest. Discharge of groundwater by evapotranspiration from the area of outcrop of the Woodbine formation is also suggested.

Groundwater is discharged through springs from the Paluxy sand and Woodbine formations and from Quaternary alluvial deposits. A large part of the discharge is from the Paluxy sand west of Lake Worth where the water table is intersected by the land surface. Groundwater also is discharged into Lake Worth, which is bottomed in the Paluxy sand. It is also probable that some groundwater is discharged into Eagle Mountain Lake (Leggat 1957).

5.2.1.2 Groundwater Quality

The Travis Peak formation generally yields water that conforms in most respects to EPA's primary drinking water standards (USEPA 1976e). The water is soft, but is unsuitable for irrigation of crops due to a high sodium bicarbonate concentration.

Water from the Paluxy sand generally is suitable for domestic, public, livestock and some industrial supplies. On the whole, it is superior to waters from the underlying Travis Peak formation and Glen Rose limestone because it is softer and considerably less mineralized.

Water from the Woodbine formation is used for domestic, public, and livestock supplies in the project region. Water from the Woodbine aquifer is more highly mineralized than water from the deeper Paluxy sand, but because of its relatively shallow depth, the Woodbine is the source of water for many wells in the eastern part of the project region. Water from the Woodbine aquifer is typically high in iron in the form of ferrous bicarbonate.

Wells in alluvial deposits of Tarrant County yield water that is very hard and high in bicarbonate. The water is satisfactory for irrigation, but because of its shallow depth the water is readily contaminated, and unless disinfected it is unsafe for domestic and public supplies.

5.2.1.3 Water Use

Table 5-4 indicates that municipalities and industries within the project region used approximately 174,983 acre-feet of water in 1974, of which about 17,000 acre-feet was supplied from groundwater sources. Most current uses of groundwater in the project region involve industrial and agricultural supply systems. Municipal supplies are provided almost exclusively through surface water reservoirs. As indicated by Table 5-4, future water supplies would depend even more heavily on surface water sources, with only 1 to 2 percent of the total regional water requirements projected to be satisfied by groundwater sources.

5.2.2 Environmental Consequences of the No Action Alternative

Implementation of the No Action alternative would result in the continued use of existing sludge drying beds. Increases in flow would result in an increase in sludge production and subsequently in an increase in undigested sludge. Presently, the sludge drying beds are unlined, and if kept in operation may become a potential source of leachate from increased moisture in the sludge.

TABLE 5-4. PRESENT AND PROJECTED GROUNDWATER AND SURFACE WATER USE IN THE PROJECT REGION

Type of Water Supply	Existing or Estimated Use (in acre-feet) for Designated Year		
	1974	2000	2030
Groundwater	17,000	5,931	4,706
Surface water	157,983	355,774	696,502
Total Water Use	174,983	361,705	701,208

SOURCE: TWDB 1977.

5.2.3 Environmental Consequences of Alternative 1

One potential groundwater quality hazard is exfiltration (i.e., leakage) from the approximately 60-mile long raw sewage pipeline connecting Village Creek to the Clear Fork, West Fork, Big Fossil and Walker Branch interceptors. However, as with all sewers and force mains in the system, leakage and groundwater quality reduction should be minimal if up-to-date engineering practices that prevent pipeline leakage are used in pipeline construction. The amount of exfiltration that would be allowed would be in compliance with the City's regulations.

Expansion of the Village Creek WWTF is expected to have only minor (if any) adverse impacts on the groundwater system. Possible minor impacts on groundwater would be due to increased urbanization associated with the proposed project, which would increase groundwater withdrawal by residences which are not included in the Tarrant County WCID No. 1 municipal water system. The amount of withdrawal is not expected to result in aquifer depletion.

Potential groundwater quality hazards posed by sludge surface application (i.e., landspreading) involve pathogens, nitrates, and toxic heavy metals, all of which can be leached from sludge through the soil column to groundwater. Pathogen contamination can result from inadequate stabilization of sludge prior to land application. However, impacts are primarily localized and of limited duration. Nitrate contamination of groundwater results from application of an excess supply of nitrogenous compounds over and above the amount which plants can utilize, and which denitrifying bacteria in the soil can denitrify. Heavy metals contamination results from application of heavy metals at amounts greater than can be contained in the surrounding soil structure. The sludge storage site also is a potential source for groundwater contamination. Runoff or leachate from piles of dewatered sludge at the storage site could carry bacteria, nitrates, and heavy metals to the groundwater. To protect groundwater, regulations governing land application of sludge (40 CFR 257) must be followed.

Sludge that would be applied at Site 1 (Figure 5-9) should have no adverse impact on groundwater. The geology of Site 1 is such that no aquifer outcrops in the vicinity of the selected sludge application site. Leachate from proposed landspreading operations would not enter the groundwater since the soils at the surface are impermeable (e.g., the Fredricsburg and Washita groups).

5.2.4 Environmental Consequences of Alternative 2A

Potential adverse impacts on groundwater due to expansion of the Village Creek plant and installation of collection mains are the same as discussed for Alternative 1 (see Section 5.2.3).

For Alternative 2A, sludge produced at the Village Creek WWTF would be disposed by codisposal in a properly designed, operated and permitted landfill. Disposal of additional sludge from the Village Creek WWTF in the landfill would not have any adverse impacts on groundwater.

5.2.5 Environmental Consequences of Alternative 2B

Expansion of the Village Creek WWTF and construction of collection mains would result in the same adverse impacts on groundwater as discussed in Alternative 1.

Disposal of sludge in a sludge-only landfill has potential for groundwater contamination if the landfill is improperly sited or improperly managed. Water seeping through a landfill can carry contaminants to the groundwater, or high groundwater levels can leach contaminants out of sludge. Surface soils at Site 2 are primarily alluvium which is moderately permeable (Figure 5-10). Soil testing at the proposed sludge-only landfill site (Site 2) indicates that 20 to 30 ft of relatively impermeable clay (on the surface) is underlain by 20 to 40 ft of silty clay, silt, sand, and gravel. Sands and gravels in the lower strata are water bearing. This water is contained by the upper clay layer and the lower formation of Eagle Ford shale. Depth to this shale varies from less than 40 feet to over 70 feet. This shale is relatively impermeable in its natural state - most permeability apparently occurs in the form of cracks or fissures. The shale can be rendered highly imper-

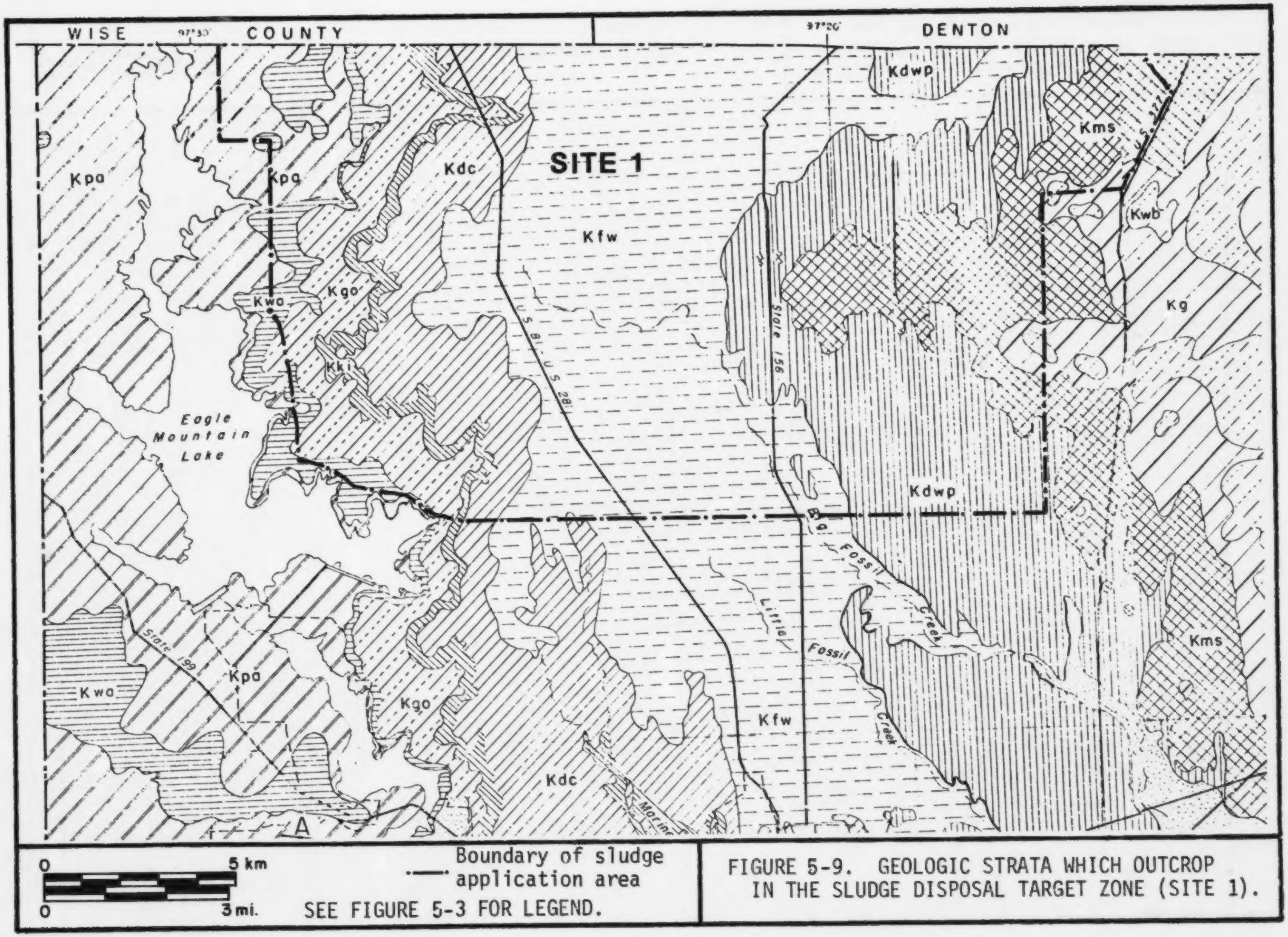


FIGURE 5-9. GEOLOGIC STRATA WHICH OUTCROP IN THE SLUDGE DISPOSAL TARGET ZONE (SITE 1).

SOURCE: LEGGAT 1957.

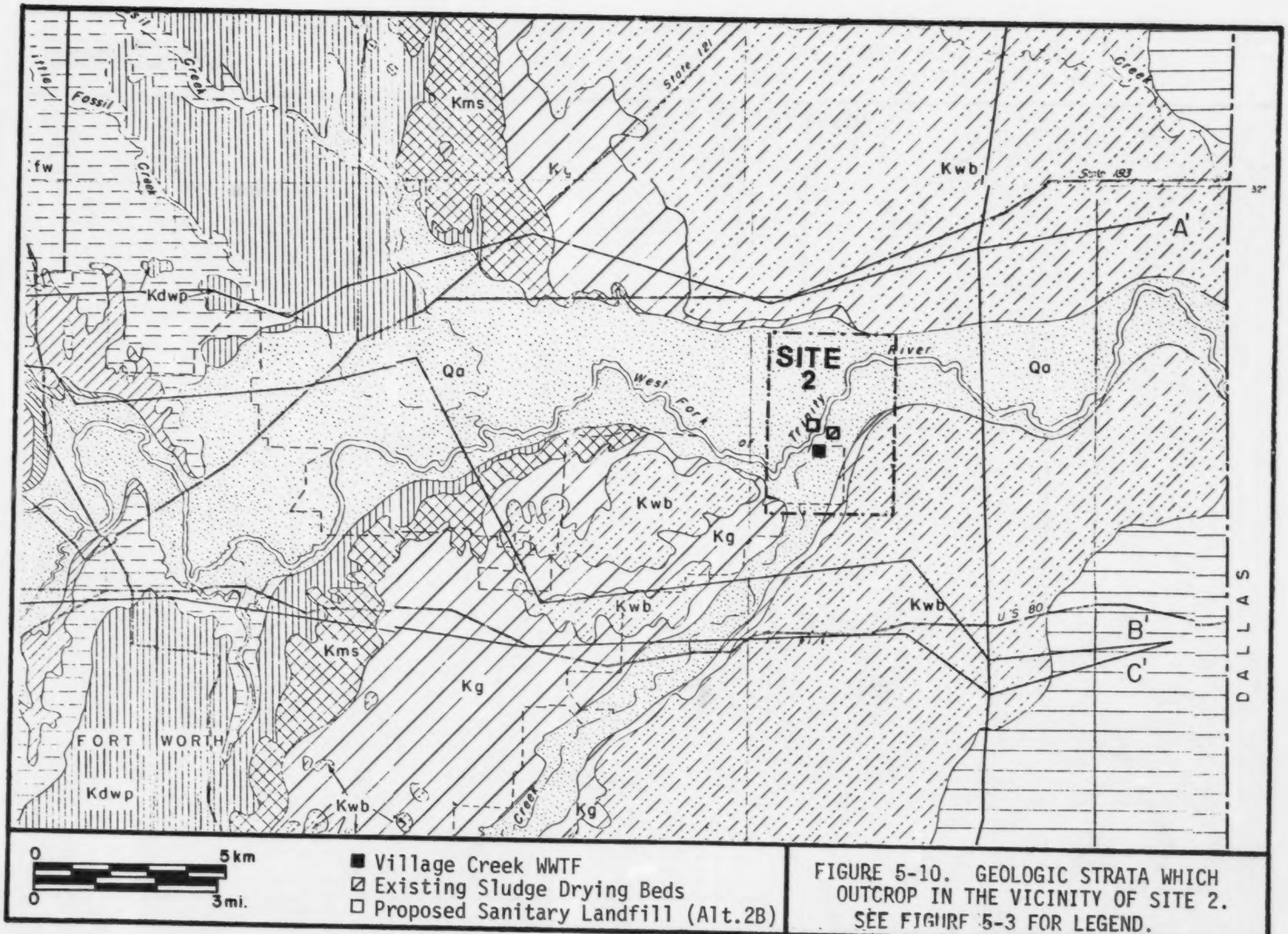


FIGURE 5-10. GEOLOGIC STRATA WHICH OUTCROP IN THE VICINITY OF SITE 2. SEE FIGURE 5-3 FOR LEGEND.

SOURCE: LEGGAT 1957.

meable by scarification and recompaction. Testing, prior to final design, would determine the acceptability of this shale as a containment layer. As described in Chapter 4.0, some landfill designs also would incorporate natural clay liners several feet thick, and/or plastic membrane liners. The exact landfill design which would be utilized currently is not specified. Sludge would be covered daily to minimize infiltration. Also, no known groundwater wells are located inside the landfill area. Thus, impacts on groundwater from sludge landfilling are expected to be minimal.

5.2.6 Environmental Consequences of Alternative 3

The Mustang Creek site (Site 3) which is to be used for slow rate irrigation of 41 mgd of wastewater is underlain by the Washita group (Figure 5-11), which is not a source of groundwater in the vicinity of Site 3. The Trinity group (Travis Peak and Paluxy Sand) is located approximately 300 to 400 feet below the ground surface within Site 3. If land treatment is well-planned and operated, Alternative 3 would have no significant adverse impact on groundwater.

5.3 SURFACE WATER RESOURCES

5.3.1. Existing Conditions

5.3.1.1 Hydrology

The project area lies within the West Fork Trinity River basin. The Trinity River basin lies in the eastern half of Texas and has an overall length of 360 mi. It extends from a 130 mile-wide headwater region, located north and west of the Fort Worth area, to Trinity Bay in Chambers County. Elevations vary from sea level at the mouth of the Trinity River basin to over 1,500 ft in extreme upper reaches of the basin. The total area drained by the Trinity River and its tributaries is approximately 17,969 square miles (sq mi) (TRA 1978b).

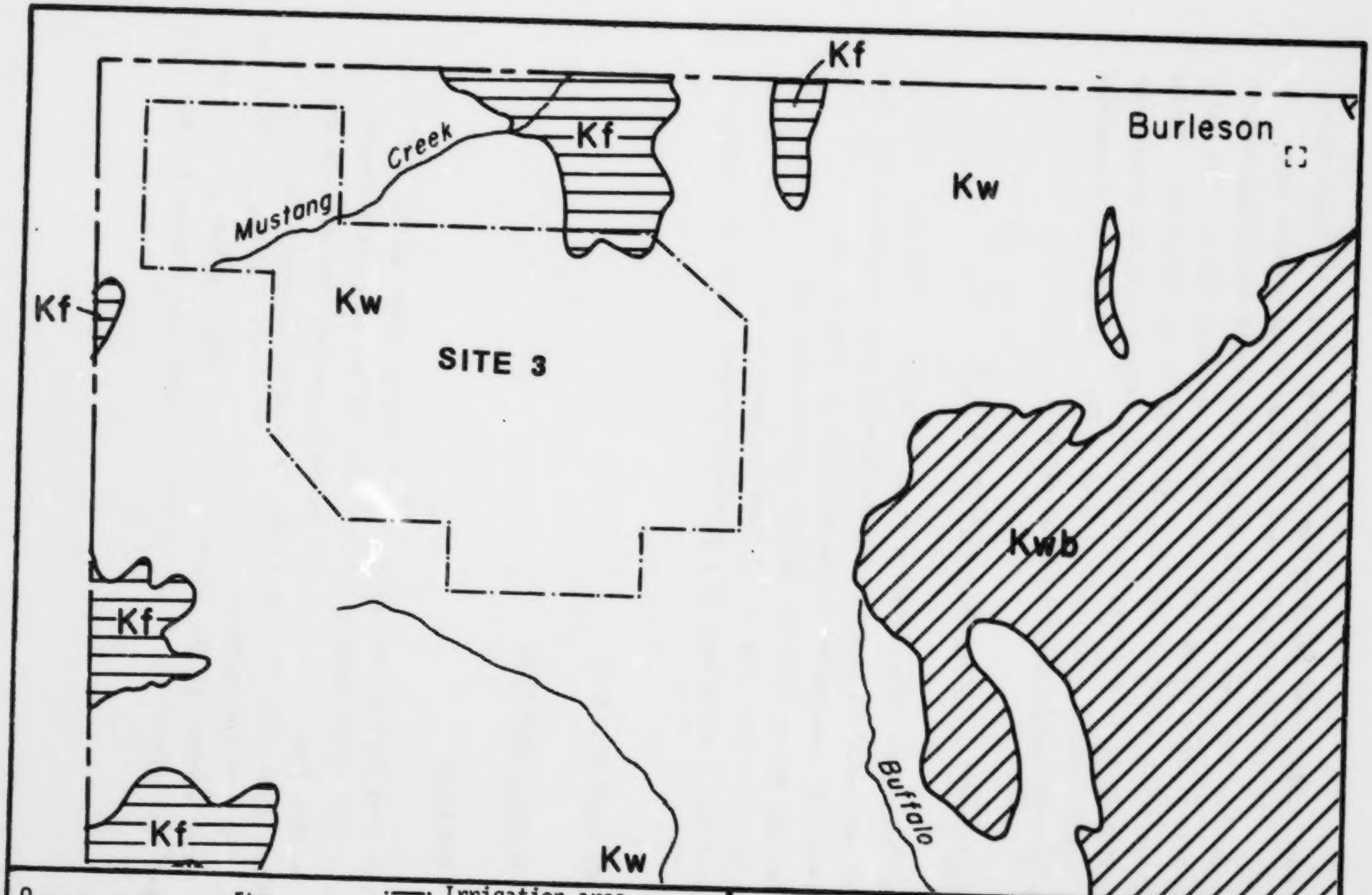


FIGURE 5-11. GEOLOGIC STRATA WHICH OUTCROP IN THE VICINITY OF SITE 3 (SOURCE: LEGGAT 1957).

The main stem of the Trinity River is formed by the confluence of three of the four major forks of the basin's drainage system. The West Fork Trinity River rises in Archer County and flows southeasterly to Tarrant County. At Tarrant County, the Clear Fork Trinity River combines with the West Fork and flows easterly to converge with the Elm Fork Trinity River in Dallas County. At this point, the main stem of the river is formed and flows south-southeast. Approximately 44 mi downstream from the beginning of the main stem, the river is joined by the East Fork Trinity River. The combined flow continues in a generally southern direction to the Gulf of Mexico.

Flows in each of the major forks partially are regulated by storage reservoirs. Bridgeport Reservoir, Eagle Mountain Reservoir, and Lake Worth are situated on the West Fork Trinity River. Their usable conservation storage capacities are 386,420; 190,460 and 38,130 acre-feet (ac-ft), respectively. The Clear Fork Trinity River is regulated by Benbrook Lake which has a usable conservation space of 72,500 ac-ft (TWDB 1977). Lewisville Lake, which has a capacity of 436,000 ac-ft., regulates flow of the Elm Fork Trinity River below Denton County. On the East Fork Trinity River, Lake Ray Hubbard and Lake Lavon regulate the flow of water.

The USGS operates several flow and water quality monitoring stations on the West Fork Trinity River. Approximately 15.9 mi upstream from the Village Creek WWTF is USGS station 48543, West Fork Trinity River at Beach Street, Fort Worth, Texas (Figure 5-12). Drainage area of the Beach Street station is 2,685 sq mi (USGS 1980). Average recorded discharge at this guaging station, based on a 4-year period of record, is approximately 174,805 ac-ft per year (242 cfs) or the equivalent of 1.22 in of runoff over the watershed annually. Maximum and minimum flows for the period of record were 18,800 cfs and 0.84 cfs, respectively. Duration of daily flow and average annual 7-day low flow for both stations is presented in Tables 5-5 and 5-6.

Downstream from the project site is USGS station 495, West Fork Trinity River at Grand Prairie, Texas. This latter station is located approximately 17.3 river mi downstream of the outfall of the Village Creek WWTF. Drainage area for this station is 3,065 sq mi (USGS 1980). Average recorded discharge at this gauging site, based on a 55-year period of record, is 389,800 ac-ft per

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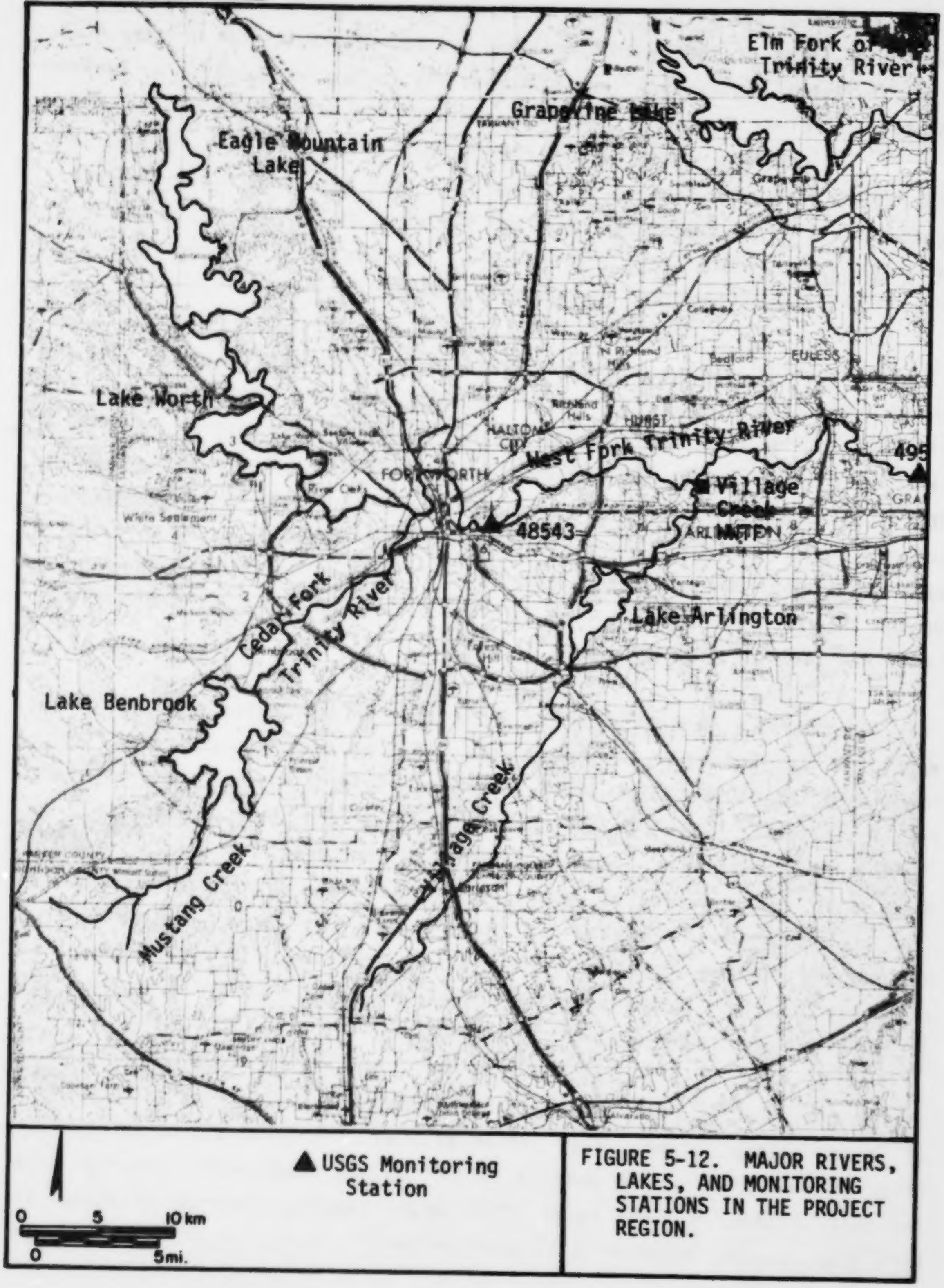


FIGURE 5-12. MAJOR RIVERS, LAKES, AND MONITORING STATIONS IN THE PROJECT REGION.

TABLE 5-5. DURATION OF DAILY FLOW FROM GAGING STATIONS LOCATED IN THE VICINITY OF THE VILLAGE CREEK WWTF.

USGS Station Number	Station Name	Period of Record	Drainage Area sq. mi.	Percent of Time Daily Discharge Equaled or Exceeded cfs						Percent of Time Daily Discharge Equaled or Exceeded cfs/sq mi					
				99	80	50	25	10	1	99	80	50	25	10	1
48543	West Fork Trinity River at Beach St. Ft. Worth	1977-81	2,685	2.7	14.0	40.0	120.0	450.0	3800.0	0.001	0.005	0.015	0.045	0.168	1.415
495	West Fork Trinity River of Grand Prairie	1926-81	3,065	13.0	69.0	120.0	350.0	1400.0	5400.0	0.004	0.023	0.039	0.114	0.457	1.762

SOURCE: USGS 1982.

TABLE 5-6. AVERAGE ANNUAL SEVEN-DAY LOW FLOW FOR VARIOUS RECURRENCE INTERVALS IN STREAMS IN THE VICINITY OF THE VILLAGE CREEK WWTF.

Station Number	Station Name	Drainage Area (sq mi)	Period of Record (yr)	Average 7-day Low Flow Rate in cfs for Specified Recurrence Interval		
				2 yr	10 yr	20 yr
48543	West Fork Trinity River at Beach St. Ft. Worth	2,865	1977-81	NA	NA	NA
495	West Fork Trinity River at Grand Prairie	3,065	1926-81	50.717	16.185	11.038

NA: Not available

SOURCE: USGS 1982.

year (538 cfs) or the equivalent of 2.38 in of runoff over the watershed annually. Maximum and minimum flows for the period of record were 62,000 cfs and 3.2 cfs, respectively.

Mustang Creek is a perennial stream in northwest Johnson County fed by laterally flowing groundwater. It flows through an agricultural area and provides farmers with stock and irrigation water. No data are available on the quality or flow in Mustang Creek (Agro City 1982).

Benbrook Lake lies approximately 1.5 mi north of the proposed land treatment site (Site 3). This man-made lake, built in 1950, drains a 429 sq mi watershed, consisting mainly of farmland. The lake's surface area covers 3770 ac; its volume is 88,250 ac-ft; and its depth averages 23.4 ft.

The Clear Fork's flow downstream of Benbrook Lake is controlled in part by Benbrook Dam. Distance from the dam to the confluence with the West Fork is approximately 13 mi. In this span, the Clear Fork drains approximately 254 sq mi, much of it now urban development. Between 1952 to 1975, its flow averaged 97 cfs (Agro City 1982).

Floodplains. Of all the three alternative project sites, only Site 2 is in the 100-yr floodplain of the Trinity River. Currently, there are four major reservoirs in the project region. Benbrook Lake was constructed by the USCOE for flood control and water supply purposes. Locally owned and operated municipal lakes in the project area include Eagle Mountain Lake, Lake Arlington and Lake Worth. The Village Creek WWTF and the sludge drying beds are adjacent to the floodplain of the Trinity River. This was recognized during previous planning for the Village Creek WWTF, and thus levees were constructed to protect the WWTF and sludge drying beds from flooding. Levees were constructed to an elevation of 484.0 feet above sea level, which according to previous studies is equal to the elevation of the 100-yr flood. According to these previous studies, levees would not protect against the "Standard Project Flood" (500-yr flood) which has an elevation of 484.5 feet (Sheaffer and Roland 1981). Under these conditions, the entire plant area and the sludge lagoons would be under about 20 ft of water. However, recent preliminary studies performed by the USCOE indicate that during the "Standard Project Flood" the water elevation at the Village Creek plant site would be 483.9 ft. In this case, the levees surrounding the Village Creek WWTF would be high enough to protect the plant from 100- and 500-yr floods (USCOE 1983a).

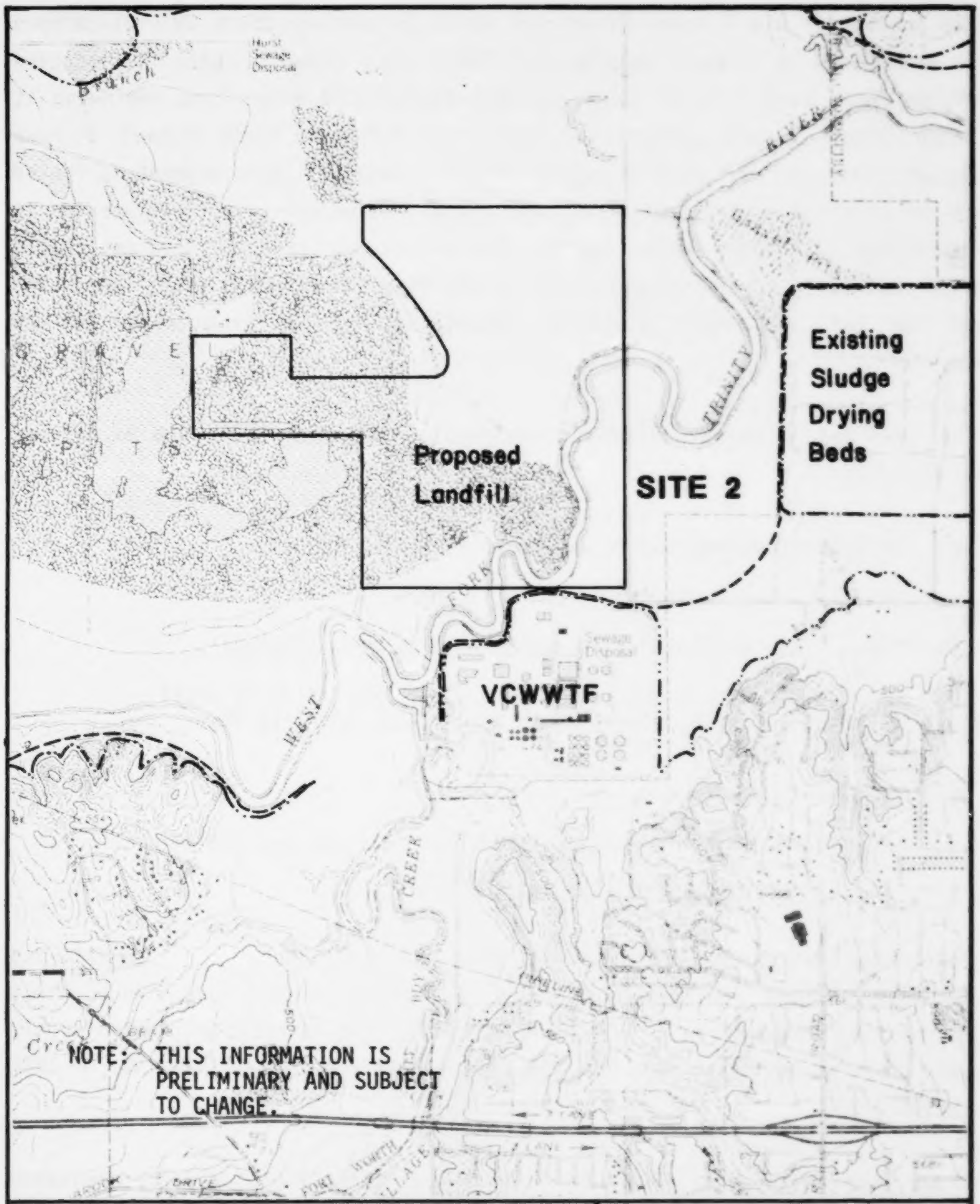
The boundary of the 100-yr flood at project Site 2, as determined by the USCOE is shown in Figure 5-13. Also indicated in Figure 5-13 are the limits of the floodway in the vicinity of the Village Creek WWTF. This floodplain and floodway information as determined by the USCOE is preliminary and subject to change. The area between the floodway limits is defined as an area in which construction of facilities (i.e., dikes, buildings placed on fill, and other obstructions to flood flow) would raise flood levels upstream, unless special channel modifications are made. For floodplain management efforts, it is a common practice to use the 100-yr flood for the purpose of establishing regulations. Construction of dikes (levees) must be permitted by TDWR. According to the USCOE, two (2) facilities in the vicinity of the Village Creek WWTF currently affect flood conditions (Mayfield 1983):

(1) The City of Arlington recently constructed a landfill, surrounded by dikes, just a few miles downstream of the Village Creek WWTF. The Arlington landfill creates an obstruction to flood flows.

(2) Levees were built around the sludge drying beds at the Village Creek WWTF. The drying bed levees restrict flood flows.

5.3.1.2. Surface Water Quality

The upper Trinity River probably has been monitored as intensively as any body of flowing water in the State of Texas (Warshaw 1976). Water quality regularly has been measured by the Texas Department of Water Resources, State Department of Health, Trinity River Authority, North Central Texas Council of Governments, US Geological Survey and the City of Fort Worth. Additional special surveys documenting present and historical water quality are those of Goff (1960), Trinity River Authority (1974, 1977, and 1978b), and North Central Texas Council of Governments (1977, 1981a, 1981b and 1982).



NOTE: THIS INFORMATION IS PRELIMINARY AND SUBJECT TO CHANGE.

SOURCE: ADAPTED FROM USCOE 1983a.

0 1 km

0 1000 2000 3000 feet

-··-Limits of floodplain

---Limits of floodway

FIGURE 5-13. LOCATION OF 100-YR FLOODPLAIN AND FLOODWAY IN THE VICINITY OF THE VILLAGE CREEK WWTF

The portion of the Trinity River into which the Village Creek WWTF discharges is designated as Segment 0805 by the TDWR. This segment, which is a portion of the West Fork Trinity River, is approximately 96 miles long beginning at Beach Street in east central Fort Worth and ending at State Highway 34 near Rosser, Texas at the eastern border of Ellis County. This segment is ranked as one of the most critical (i.e., worst quality) segments in the State and is classified by TDWR as "water quality limited" (i.e., currently does not comply with applicable stream standards and is not expected to do so after imposition of the 1977 wastewater standards established by the Clean Water Act as amended).

The TDWR water quality standards applicable to Segment 0805 are as follows (TDWR, 1981):

- Chloride, average not to exceed - 175 mg/l;
- Sulfate, average not to exceed - 175 mg/l;
- Total Dissolved Solids, average not to exceed - 850 mg/l;
- Dissolved Oxygen - not less than 3.0 mg/l when flow is equal or greater than 80 cfs at Beach Street, and not less than 1.0 mg/l when flow is less than 80 cfs;
- pH Range - 6.5 to 9.0;
- Fecal Coliform - log average not more than 2,000 per 100 ml;
- Temperature - not to exceed 95°F.

Designated water uses for Segment 0805 now include only irrigation and industrial supply. Other previously designated uses, including contact recreation, propagation of fish and wildlife, and domestic raw water supply were deleted by water quality standards revisions issued by TDWR in 1981 (White 1983).

Known water quality problems in this segment include periodically depressed and critically low levels of dissolved oxygen. Potential water quality problems include high nutrient and fecal coliform levels throughout the segment. Elevated levels of PCB's and some heavy metals have been found in water samples collected from the segment. Sediment in the segment has been found to contain accumulated levels of chlordane, DDD, DDE, DDT, dieldrin, heptachlor epoxide, PCB's and heavy metals. Quality and streamflow in this segment is dominated by effluent from the Dallas-Fort Worth metropolitan area (TDWR 1980).

Two intensive surveys have been conducted by TDWR during moderate to low flow conditions on the West Fork Trinity River. The first survey was conducted in September 1982 when the river was at low flow upstream from the Elm Fork confluence and at moderate flow conditions downstream. The second survey was conducted in October 1982 when flow conditions of the first study were reversed. Both surveys included sampling on the West Fork at 27 mainstream stations, four tributaries, and seven municipal sewage treatment plants. Diurnal field measurements, composite water samples and extensive hydrological data (flows, cross sections, and time-of-travel) were collected on both studies. The gaseous tracer method was used to determine stream reaeration rates on the second survey (White 1983). In addition to these two sets of data, the USGS has collected five sets of hydraulic data from the West Fork Trinity (1972-1980). One of their studies also included determinations of stream reaeration rates.

TDWR has begun collating data from the above mentioned sources but the work is in the very early stages of preparation. Enough data exists to calibrate a computer water quality model for Segment 0805, but an additional set of low flow data throughout the entire length of the segment will be needed for model verification. TDWR intends to collect additional water quality and hydraulic data in the summer of 1983. The model is scheduled to be calibrated and verified by December 1983. TDWR also feels that a variable flow analysis to evaluate seasonal permits for Segment 0805 and new wasteload allocations may be completed by June 1984 (White 1983).

Water quality of the West Fork Trinity River upstream and downstream from the Village Creek WWTF is being monitored by a Continuous Automated Monitoring (CAM) system. The CAM system was designed as a part of basinwide planning activities in 1974, and was installed by the USGS during late 1976-1977 through an interagency agreement with NCTCOG as a part of the areawide planning program. Data from CAM Report 82-1 are presented in Table 4-11 (see

Chapter 4.0 of this EIS). No water quality data are available for Mustang Creek. Tables 5-7 and 5-8 present analyses of water quality in Lake Benbrook and the Clear Fork Trinity River.

The quality of effluent discharged from the Village Creek WWTF has a significant impact on the quality of water in the Trinity River, since it is such a large portion of the river's total flow. At a gauging station at the confluence of the Clear and West Forks, approximately 25 river miles upstream of the Village Creek WWTF, the average river flow in the late 1960's was 250 mgd (386 cfs). This average river flow strongly reflects storm flows that occur during a relatively short time period annually. But during the period from October 1967 to September 1968, for example, the minimum river flow was 0.7 mgd, and flow was less than 7 mgd 60 percent of the time. Downstream of the WWTF at the Grand Prairie gauge, Fort Worth's treated effluent flow of about 60 mgd represented at least half the river flow 48 percent of the time (CDM et al. 1971). Stream water quality and effluent quality are roughly equivalent for a major part of the time. Thus, the Village Creek WWTF effluent and effluents from other plants downstream directly control the ability of Segment 805 of the Trinity River to support aquatic life.

Effluent limitations for the Village Creek WWTF are based on water quality standards developed by TDWR and approved by EPA. At the time the expansion to 96 mgd of the Village Creek WWTF was being planned in 1971, standards were set by the Texas Water Quality Board (now TDWR). Since the 1972 passage of the Federal Water Pollution Control Act Amendments, effluent limitations are set forth in a National Pollutant Discharge Elimination System (NPDES) permit. Such a permit was issued to the Village Creek WWTF on 26 October 1974. This permit contained both interim and projected effluent limitations (Table 5-9). Interim limitations were to be in effect until 1 May 1977, and included controls on flow as well as concentrations of BOD, TSS, and fecal coliform bacteria in the effluent. The permit also required that, in order to maintain water quality standards for the Trinity River, a limit on ammonia nitrogen and more stringent controls on BOD and TSS were necessary. The permit required the City of Fort Worth "to commence studies and the preparation of plans to attain limits of 5/5/5 (BOD/TSS/NH_3N) at the earliest possible date."

Table 5-7. ANALYSIS OF WATER FROM LAKE BENBROOK

CHEMICAL-PHYSICAL
(10-1-74 through 6-30-76)

Water Analyses - Benbrook Lake (FW; TPWD; TWQB 0830.01; USGS 08046500). All concentrations are in mg/l, unless otherwise specified. All samples are surface samples.

Parameter	Mean	Maximum	Minimum
Temperature (C)	24.700	30.000	7.500
Dissolved Oxygen	7.900	11.200	5.300
pH (pH units)	8.000	8.400	7.500
Conductivity (umhos/cm)	335.000	375.000	240.000
Total Suspended Solids	13.000	28.000	9.000
Volatile Suspended Solids	7.000	16.000	4.000
Total Dissolved Solids	179.000	230.000	120.000
Total Solids	210.000	236.000	196.000
Ammonia, as N	0.330	1.500	0.000
Nitrate, as N	0.090	0.150	0.040
Orthophosphate, as P	0.017	0.033	0.008
Total Phosphate, as P	0.045	0.065	0.015
Chloride, as Cl	31.000	129.000	6.400
Sulfate, as SO_4	23.000	26.000	21.000
Total Alkalinity, as $CaCO_3$	158.000	360.000	100.000
Bicarbonate, as HCO_3	140.000	184.000	108.000
Carbonate, as CO_3	5.000	14.000	0.000
Total Hardness, as $CaCO_3$	132.000	159.000	120.000
Noncarbonate Hardness, as $CaCO_3$	8.000	8.000	8.000
Chlorophyll a (ug/l)	12.000	15.000	8.000
Secchi (cm)	83.200	122.800	49.400
Turbidity (JTU)	9.000	28.000	4.000
Biochemical Oxygen $Demand_5$	3.000	5.000	1.000
Total Organic Carbon	15.000	15.000	15.000
Sodium Absorption Ration, SAR	0.600	0.600	0.600
Fecal Coliform (#/100 ml)	15.000	31.000	5.000
Aluminum, as Al_2O_3	0.070	0.080	0.050
Calcium, as Ca	44.000	59.000	38.000
Fluoride, as F	0.200	0.230	0.180
Iron, as Fe	0.050	0.060	0.040

SOURCE: NCTCOG 1976.

TABLE 5-8. ANALYSIS OF WATER FROM THE CLEAR FORK, TRINITY RIVER

CHEMICAL-PHYSICAL
(10-1-74 through 6-30-76)

Water Analyses - Clear Fork Trinity River (FW 1, 2; TWQB 0829.01; USGS 08046500). All concentrations are in mg/l, unless otherwise specified.

Parameter	Mean	Maximum	Minimum
Temperature (C)	17.90	27.20	9.00
Dissolved Oxygen	9.20	13.20	7.20
pH (pH units)	7.8	8.2	7.3
Conductivity (umhos/cm)	425.00	557.00	280.00
Total Suspended Solids	59.00	309.00	10.00
Volatile Suspended Solids	6.00	12.00	0.00
Total Dissolved Solids	230.00	262.00	140.00
Ammonia, as N	0.49	1.40	0.00
Nitrate, as N	0.12	0.33	0.00
Total Phosphate, as P	0.18	0.64	0.02
Orthophosphate, as P	0.08	0.15	0.02
Chloride, as Cl	27.00	91.00	15.00
Sulfate, as SO_4	37.000	56.00	21.00
Chlorophyll a (ug/l)	5.00	11.00	2.00
Fecal Coliform (#/100 ml)	103.00	3570.00	10.00
Biochemical Oxygen Demand$_5$	2.00	4.00	1.00
Turbidity (JTU)	24.00	63.00	7.00

SOURCE: NCTCOG 1976.

TABLE 5-9. COMPARISON OF VILLAGE CREEK WWTF EFFLUENT LIMITS.

Discharge Permit	Effluent Limits (30 Day Averages) Flow mgd	BOD mg/l	TSS mg/l	NH_3 mg/l	Fecal Coliform No./100 ml
Texas Water Quality Control Board (1969)	--	20	20	--	--
NPDES Permit TX0047295 (October 26, 1974)					
Interim (Until 5/1/77)	55(a)	20	45	--	200
Projected	--	5	5	5	200
Texas Water Control Order Number 10494 (November 26, 1974)					
Interim (until 96 mgd plant operational)	--	20	20	--	--
Operational	--	10	10	--	--
Projected	--	5	5	3	--

(a) Maximum day shall not exceed 125 mgd.

SOURCE: USEPA 1979c.

The NPDES permit limits were further supported by TDWR Waste Control Order Number 10494, which became effective on 26 November 1974. Under this order the Village Creek WWTF was authorized to discharge in accordance with interim effluent limitations of 20/20 (BOD/TSS) until construction for expansion to 96 mgd was complete and a reasonable time had been allowed for start-up. After this period, 10/10 effluent limitations would become effective. The TDWR permit also required Fort Worth to commence with study and preparation of plans to attain projected 5/5/3 (BOD/TSS/NH_3N) effluent limits at the Village Creek WWTF.

The NPDES permit expired in 1977, and since has been administratively extended until a new permit is issued. No final decision on future permit limitations has yet been made by TDWR or EPA pending outcome of additional water quality/waste load allocation studies to develop effluent limitations necessary to attain the revised water quality standards (see Section 4.3.4). In the interim, TDWR advised Fort Worth to develop the facilities plan based on discharge permit limits of 10 mg/l BOD and 15 mg/l TSS.

The current "official" wasteload allocation for Segment 0805 includes limits of 5/5/3 for the Fort Worth wastewater treatment facilities. This wasteload allocation was developed to meet the water quality standards in effect prior to the revisions that were made in 1981. Consequently, none of the alternatives developed by the City of Fort Worth in the draft facilities plan would produce an effluent which would meet the limits established in the current wasteload allocation. The average wasteload (i.e., pounds of pollutants per day) discharged by the Village Creek WWTF for 1979 through 1982, the wasteload determined allowable by TDWR's wasteload allocation prior to the 1981 stream standard revisions, and the wasteloads which would be discharged by implementation of one of the four final alternatives are as follows:

Parameter	Existing Village Creek WWTF (85 mgd)		Existing Waste Load Allocation (137 mgd)		Proposed Discharge for Alternatives			
					1, 2A, 2B (137 mgd)		3 (96 mgd)	
	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day	mg/l	lbs/day
BOD	35	24,812	5	5,713	10	11,426	10	8,006
TSS	64	45,370	5	5,713	15	17,139	15	12,010
NH_3N	20	14,178	3	3,428	20	22,852	20	16,013

As indicated, the final alternatives do not meet the current wasteload allocation. However, the TDWR is conducting wasteload allocation studies to determine what effluent limitations would be required to meet current stream standards.

5.3.1.3 Water Supplies, Water Use and Water Rights

Water from Segment 0805 of the West Fork Trinity River currently is not used as a domestic or municipal water supply. According to the TRA, no water rights permits have been issued for diversion of water from Segment 0805 for any use, including industrial and agricultural purposes. Downstream of the Dallas/Fort Worth metroplex, water in the Trinity River is used for agricultural irrigation, livestock, and as the raw water supply into Lake Livingston which is subsequently used by the City of Houston for municipal purposes. The current designated uses of Segment 0805 of the Trinity River are irrigation and industrial use. The only activities occurring in this segment of the river are fishing for rough fish and hunting turtles.

The major supplier of raw water for municipal uses in the project region is the Tarrant County Water Control and Improvement District Number One (TCWCID). Actual water requirements within the TCWCID service area vary from year to year, depending upon actual growth rates and drought conditions. For example, average demand in the year 2010 could increase by 21 percent from 287 mgd to 347 mgd if the "maximum" growth rate occurs and if drought conditions prevail. This, in turn, would increase the need for new water supplies by 70 percent, from 116 mgd to 197 mgd.

The two major sources of raw water supply for the TCWCID are its West Fork reservoir system and Cedar Creek Reservoir. The West Fork system consists of three reservoirs (Lakes Bridgeport, Eagle Mountain and Worth) and is the preferred source since it provides raw water to the TCWCID system via gravity flow. Available supply from the West Fork system currently is 75 mgd. The Cedar Creek source, which requires pumping water from Cedar Creek Reservoir, is limited to 160 mgd. The long term dependable yield of Cedar Creek Reservoir, however, is limited to 138 mgd. Thus, the combined long term yield of the West Fork and Cedar Creek systems is about 210 mgd. Water supply requirements for the project region are expected to exceed this capacity sometime before 1995 (TCWCID 1979).

The TCWCID has implemented plans to construct a dam across Richland Creek, creating a reservoir (Richland-Chambers) of 44,752 surface acres in Freestone and Navarro counties, Texas. The Richland-Chambers reservoir will be located 5.4 miles upstream of Richland Creek's confluence with the Trinity River. The Richland-Chambers reservoir will contain 1.2 million ac-ft of water and will have a normal operating level of 315 feet msl. Completion of Richland-Chambers reservoir is anticipated in 1988 (USCOE 1982).

The cities of Benbrook and Fort Worth currently use Benbrook Lake for municipal water supply; it also is used for recreation. No industrial or agricultural facility is authorized to make direct use of Benbrook Lake's waters (NCTCOG 1976). NCTCOG, in its 1980 Water Quality Management Plan, deemed Benbrook Lake as having desirable water quality and uses. Some water below Benbrook Dam is withdrawn for irrigation.

Current uses of the Clear Fork Trinity River focus on recreation. Fort Worth has built along its course several well-received recreation facilities including: nature areas, a golf course, bicycle routes, and jogging paths.

5.3.2 Environmental Consequences of the No Action Alternative

Implementation of the no action alternative would result in discharge of 112 mgd of raw sewage into the Trinity River during receipt of peak 2-hr flows of 438 mgd. Also, 60 mgd would receive only primary treatment, 153 mgd would receive only secondary treatment and the rest of the peak flow (113 mgd) would receive advanced secondary treatment. Discharge of excess BOD and nutrients to the Trinity River would decrease dissolved oxygen (DO) levels and accelerate the process of eutrophication. Algal blooms could occur below the Village Creek WWTF outfall in the West Fork Trinity River where 50 percent of the time the flow is less than 26 mgd (40 cfs). Other pollutant loads (i.e., ammonia-nitrogen, BOD, phosphorus, suspended solids and fecal coliform) would continue to increase below the Village Creek WWTF outfall.

Until recently the present Village Creek WWTF has not consistently produced an effluent of 10/15. Implementation of the no action alternative would result in continued difficulty meeting effluent limitations.

5.3.3 Environmental Consequences of Alternative 1

Streams draining the project region are small relative to the proposed wastewater discharge. Fifty percent of the time, flow upstream from the Village Creek WWTP outfall was less than 40 cfs (26 mgd). Consequently, perhaps the largest direct hydraulic impact of Alternative 1 would be increased augmentation of base flows in the West Fork Trinity River, especially in the upper reaches just below the Village Creek WWTF outfall. Adverse effects due to this increased flow would include downstream channel erosion during low flows. However, the increased assimilative capacity of the West Fork Trinity River below the Village Creek WWTF outfall due to higher low flows would be a substantial benefit.

Impacts to streamflow associated with necessary construction activities in or near the West Fork Trinity River are minor, temporary and of no identified consequence. Increased flooding potential as a direct result of the wastewater discharge to the West Fork Trinity River is negligible (the increase in peak 2-hour discharge from the Village Creek WWTF would be approximately 4 percent of the 100-yr flood flow of the Trinity River).

Secondary impacts to streamflow rates may occur due to continued development of the area's watershed. Major effects of this increased urbanization would include higher flood peaks, more frequent flooding, and if extensive, significant decreases in natural low flows of area streams. The volume of runoff and groundwater recharge which occurs during storm events is governed primarily by infiltration characteristics of a watershed. As urbanization decreases permeability of the land surface (e.g., due to rooftops, streets and parking lots), groundwater recharge and the subsequent flow to surface waters would decrease.

With implementation of Alternative 1, water quality of the West Fork Trinity River would be expected to improve as better quality effluent would be discharged. Chief pollutants subject to control at the Village Creek WWTF are oxygen-demanding materials of carbonaceous and nitrogenous origin (e.g., BOD and NH_3N), suspended solids, and pathogenic bacteria. Maintenance of a satisfactorily high dissolved oxygen (DO) content is critical to aquatic biota and in preventing formation of noxious, often malodorous compounds that usually are a result of anaerobic degradation. In wastewater treatment, water quality in a receiving stream is protected by removing oxygen-demanding material from wastewaters, and by charging the wastewater with DO before discharge. The Village Creek WWTF during the last four years has discharged an average BOD load of 24,812 lbs per day (effluent having BOD of 35 mg/l and a flow of 85 mgd). At the design discharge, BOD loads from the WWTF would be reduced to 11,426 pounds per day (effluent having a BOD of 10 mg/l at a flow of 137 mgd). Qualitatively then, although more treated wastewater would be entering the Trinity River from the Village Creek WWTF, less pollutants would be discharged to the river. Ultimately, this improved effluent would be reflected by better stream quality with respect to DO.

Construction activities associated with Alternative 1 (i.e., Village Creek WWTF expansion and sewer interceptors) would have the potential for degrading water quality with suspended and bedload solids from erosion of disturbed material. However, only a small amount of construction would be required at the Village Creek WWTF, and all disturbance would be within the flood-protection levees. This should result in effective sediment control. Construction of sewer interceptors has the potential for significantly increasing sediment loads in area streams; however, this situation is expected to cause only temporary, minor effects if adequate sediment control plans are followed.

Dewatered sewage sludges potentially would contain measurable amounts of heavy metals and organics in addition to measurable amounts of coliform bacteria and ammonia-containing compounds (NH_3, NO_3, and organically bound nitrogen). All of these materials can adversely affect the quality of surface waters if deposited into streams in sizeable quantities. Primary impacts to surface water could include degradation of water quality from erosion of soils containing sludge into surface waterways. This could lead to increases in turbidity, BOD, and metals, and decreases in DO in the streams. A secondary impact could involve deposition of silts on stream bottoms, and changes in benthic habitat. However, such impacts are prevented to a great extent by current State and Federal regulations concerning land application of sludge.

The area (Site 1) considered for sludge application is drained by a number of surface rivers and streams. These include several unnamed tributaries of the West Fork Trinity River (which drains into Eagle Mountain Lake) on the western side of the sludge application area, and Henrietta Creek, Elizabeth Creek, Big Bear Creek and tributaries of Big Fossil Creek on the eastern side of the sludge application area. Solid waste disposal regulations (40 CFR Part 257) provide for control of sewage sludge application directly to land and control of surface runoff and erosion to preclude substantial impact from these operations on surface waters. Since the exact location of the 20,000 ac sludge landspreading site is unknown, it is difficult to evaluate exactly which surface water streams or rivers in the area could be impacted. Proper site management in compliance with requirements of the Texas Solid Waste Act, Texas Water Code and other regulations of the TDWR and Texas Department of Health should effectively eliminate adverse surface water impacts.

Implementation of Alternative 1 would support more extensive growth in the study region than would exist without the project. The change would secondarily affect the water quality of the Trinity River because storm drainage from urban areas typically is of poor quality with substantial amounts of suspended solids, pathogens, oil and grease, oxygen demanding material, nutrients, and toxic substances (pesticides, herbicides, etc.). This quality generally improves with time during a storm event, and the total mass and concentration of a given pollutant that reaches a stream depends on many factors. An overall improvement in water quality of the Trinity River still would be anticipated, because pollutant loadings removed by an expanded and improved WWTF on a daily basis potentially would outweigh pollutants contributed by urban non-point sources during storm events.

Implementation of Alternative 1 and the resulting improvement in water quality of the Trinity River would result in increased potential for non-contact recreational uses downstream of the Village Creek WWTF. Recreational uses of upstream lakes and streams would not be altered. Water rights on segments downstream of the Dallas-Fort Worth metroplex would be satisfied by increased streamflows resulting from discharge of 137 mgd, as compared with the current discharge of 96 mgd.

5.3.4 Environmental Consequences of Aternative 2A

Impacts on hydrology, water quality, water rights, water use and water supply associated with expansion of the Village Creek WWTF would be equal to those described for Alternative 1.

For Alternative 2A, sludge produced at the Village Creek WWTF would be disposed by co-disposal in a properly designed, operated and permitted landfill. Disposal of sludge from the Village Creek WWTF in an existing municipal refuse landfill would not result in any additional substantial adverse impacts on surface water resources.

5.3.5 Environmental Consequences of Alternative 2B

Impacts on hydrology, water quality, water rights, water use and water supply associated with expansion of the Village Creek WWTF would be equal to those described for Alternative 1.

For Alternative 2B, sludge would be disposed in a landfill owned and operated by the City. The City of Fort Worth would have to follow the solid waste regulations for operation and construction of sanitary landfill facilities. These rules require that land disposal sites and facilities not be located where there is a reasonable probability that disposal of solid waste would have a detrimental effect on surface water. The only surface water in the vicinity of the landfill area is the West Fork Trinity River. In addition, a plan of operation for the proposed facility (landfill) must be presented to the Texas Department of Health for approval, and must include detailed information on drainage patterns and drainage control structures which are designed to prevent surface water impacts. The City also would be required to obtain a levee permit from the TDWR, a Section 404 permit from the USCOE if there is a discharge of dredge or fill material into waters of the United States including adjacent wetlands, and a Section 10 permit from the USCOE for any work in navigable waters of the US.

To prevent major adverse impacts on water resources, it would be necessary to construct levees around the landfill, and to construct a relief channel to handle overbank flow so that the water level during a 100-year flood is not raised. Preliminary studies conducted by the City indicate this is possible.

Soil loss from an approved landfill would be limited to that occurring as a result of initial construction. Although no site specific requirements are known presently, extensive runoff or erosion from the active portion of the landfill site would not be permitted. Consequently, adverse surface water impacts are not likely due to construction and operation of the landfill.

The City's draft facilities plan also suggests that experimental beneficial sludge reuse programs would be conducted in the remaining parts of the 500-ac site across the river from the Village Creek WWTF. The landfill would utilize approximately 92 to 185 ac of land, depending on the exact landfill design utilized. Approximately 300 ac would remain outside of the levees surrounding the landfill, of which approximately 100 ac would be taken by the 800-ft wide flood relief channel. Sludge reuse programs conducted on the remaining 200 ac outside of the levees potentially would include landspreading of dewatered sludge and/or surface injection of liquid sludge. Since these activities would not be protected by levees, sludge containing bacteria, toxic materials, and organic and inorganic solids potentially could be washed downstream during major flood events.

Any sludge disposal activities must be conducted in compliance with applicable regulations, including those dealing with disposal of sewage sludge under the Resource Conservation and Recovery Act (40 CFR Part 257). Certain activities in the floodplain may be prohibited under those regulations.

The flood relief channel would have an 800 foot bottom width, with 5:1 side slopes and a total length of approximately 6,100 feet. In addition, levees around the northwest corner of the existing sludge drying beds would be reconstructed as much as 1,240 feet back from its original location. Also, existing gravel pit spoil piles south of the relief channel would be levelled to below the 470 ft msl elevation. During a 100-year frequency flood, the water surface elevation in the Trinity River would be as much as 0.4 feet lower than the water surface elevation under existing conditions. It is therefore possible to construct the landfill within the floodway without adversely affecting flooding, as long as additional channel improvements (such as the proposed channelization and relocation of levees) also are made.

Upstream from the landfill, due to Alternative 2B, velocities in the Trinity River will increase from existing conditions by ±0.3 feet per second (fps) in the river channel and ±0.1 fps in the overbank area. Adjacent to the landfill, the maximum velocity increase in the main channel would be from 2.7 fps to 4.3 fps; the left overbank velocity would increase from 1.1 to 1.5 fps, and the right overbank velocity would increase from 0.7 fps to 1.0 fps. In the transition section - from the landfill to the sludge drying beds - velocities are identical under both conditions (2.2 fps). Adjacent to the sludge drying beds velocities would drop from 4.6 fps to 3.5 fps, and downstream from the sludge drying beds flood velocities under existing conditions and those occurring after implementation of Alternative 2B would be identical. The maximum velocity anywhere under current flood conditions is 5.8 fps and is in the main channel. After construction of Alternative 2B, the maximum velocity anywhere would be 5.2 fps (CDM 1983a).

Toxic materials contained in the Trinity River bottom sediments (TDWR 1980) potentially would be released during construction of the flood relief channel. If channel lining is not provided, erosion of toxic sediments from the channel bottom and sides also could occur during each flood event. These toxic sediment washouts potentially could cause adverse water quality and health effects downstream of the proposed landfill.

Toxic pollutants specifically identified at elevated levels in water samples collected from Segment 0805 of the West Fork Trinity River included polychlorinated biphenyls (PCBs) and heavy metals (not specified). Sediment samples were found to have accumulated levels of chlordane, DDD, DDE, DDT, dieldrin, heptachlor epoxide, PCBs, and heavy metals (TDWR 1980). Exact concentrations of the toxic pollutants were not specified in the TDWR report. Water quality and health effects caused by these toxic pollutants include, but are not limited to, the following (USEPA 1976):

Pollutant	EPA Recommended Maximum Concentration	Possible Effects When USEPA Levels Exceeded
PCBs	0.001 ug/l	Toxic to aquatic life; causes skin lesions in humans.
Heavy metals	1.0 to 50 ug/l	Toxic to aquatic life; brain damage in humans.
Chlordane	0.01 ug/l	Toxic to aquatic life; potential carcinogen.
DDD, DDE, DDT	0.001 ug/l	Toxic to aquatic life; potential carcinogen.
Dieldrin	0.003 ug/l	Toxic to aquatic life; potential carcinogen.
Heptachlor	0.001 ug/l	Toxic to aquatic life; potential carcinogen.

5.3.6 Environmental Consequences of Alternative 3

Due to modification of the Village Creek WWTF, a small increase in the base flow of the West Fork Trinity River would result; however, its effect would be less than that discussed for Alternative 1.

Land treatment of wastewater (41 mgd) would cause several changes in the hydrologic characteristics of the waterways in the vicinity of the land application site (Site 3). Streams that would be affected include Mustang Creek, Nolan River and Wallace Branch. Site drainage of Mustang Creek, Nolan River and Wallace Branch would be affected by changes in soil characteristics, spacing of irrigation equipment and changes in crop cover. Also, flow patterns in the Nolan River and Wallace Branch (both streams being in the Brazos River basin) would be affected since all drainage and recovered effluent from the land treatment system would be pumped to the aerated lagoon system located in the Trinity River basin. This would result in an increased flow in Mustang Creek and a decreased flow in the Nolan River. Of the 41 mgd being treated by the land treatment system, it is estimated that approximately 10 to 12 mgd would be recovered and discharged to Lake Benbrook. This would result in an increase of flow to Lake Benbrook. Secondary impacts on surface water hydrology of the West Fork Trinity River as discussed for Alternative 1 also would be applicable to this alternative.

A well-planned, well-run slow rate irrigation system would result in no significant adverse impacts on the quality of surface waters in the vicinity of the land treatment site. The key element to avoiding contamination of surface water quality is the hydraulic loading rate (this parameter is used to determine the land area required for the slow rate system). Proposed rates of 1.25 inches per week are at the lower end of rates suggested by EPA guidelines (USEPA 1976d).

Although a design water balance is not in the draft facilities plan, contaminated surface runoff from the slow rate irrigation system is expected to be minimal or non-existent (USEPA 1976d).

Beneficial impacts resulting from increased flows being discharged to Lake Benbrook would include: (1) water could be used as a source of raw water supply for the project region; (2) water could be released for downstream recreation on the Clear Fork Trinity River; and (3) water could be pumped into the Village Creek watershed so that it flows into Lake Arlington.

Water rights potentially would be affected by implementation of Alternative 3. The City of Fort Worth and other cities in Tarrant County currently have water rights (via the TCWCID) to withdraw water from the West Fork basin for municipal use. Rights to withdraw water for municipal use are granted by TDWR with the assumption or understanding that a certain percentage (not specified) will be returned via non-point and/or point source discharges to the stream, such as treated wastewater discharges (Boyd 1983). A substantial portion of the wastewater used for irrigation (i.e., 31 mgd out of 41 mgd total) in Alternative 3 would not be returned as a point discharge to the West Fork Trinity River. The City currently does not have the right to utilize water for irrigation, and would have to obtain a "secondary use permit" for water rights from the TDWR before Alternative 3 could be implemented.

5.4 AIR AND SOUND QUALITY

5.4.1 Existing Conditions

5.4.1.1 Climate

The climate in the project region is humid with hot summers and mild winters. This type of climate is characterized by a wide range in annual temperature extremes. Average precipitation varies considerably from year to year, ranging from less than 20 to more than 50 inches.

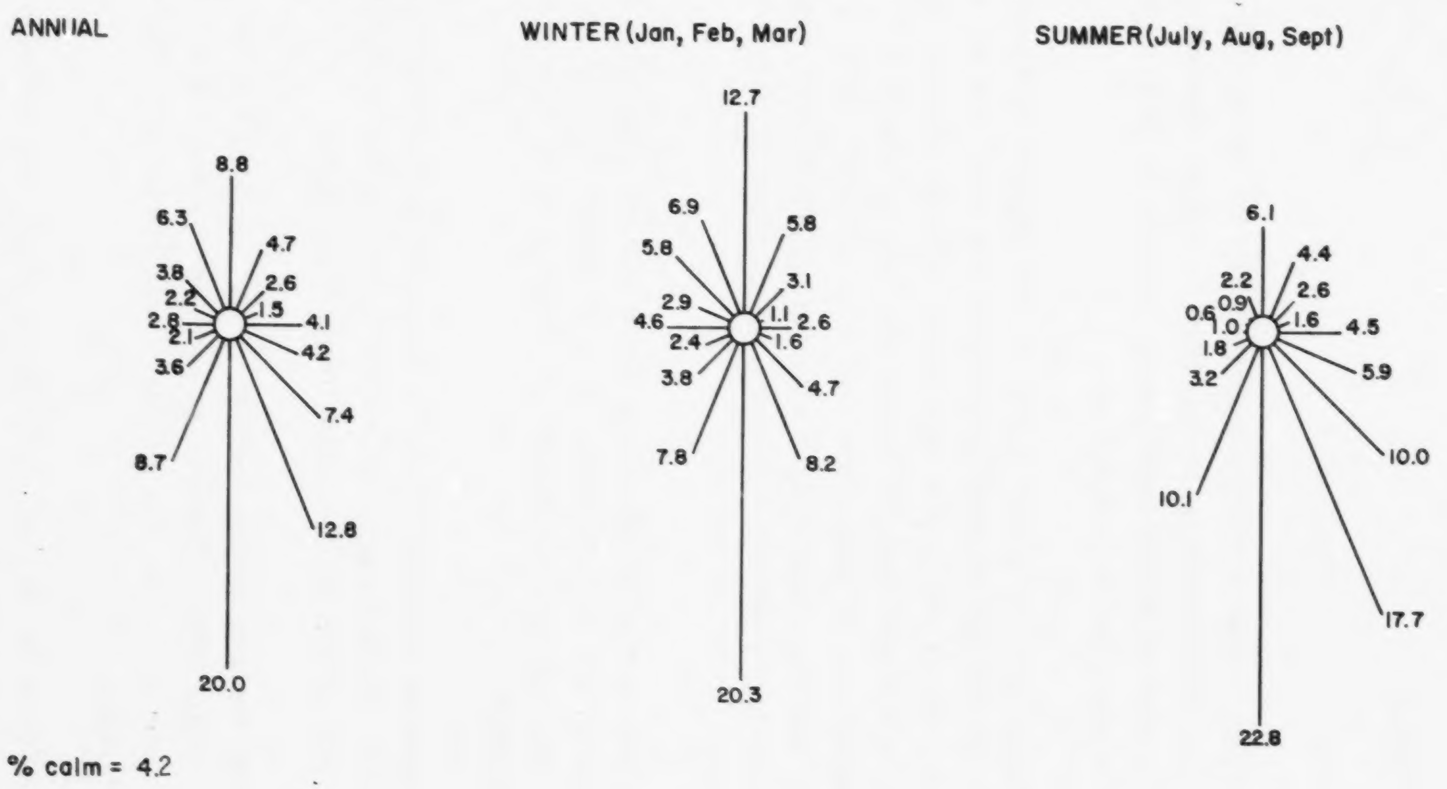
Average annual mean temperature in Tarrant County is 65.7 degrees Fahrenheit (°F). Average annual maximum and minimum temperatures are 76.1° and 55° F, respectively. There are only a few nights each summer when the minimum temperature exceeds 80° F, but a year when the temperature does not exceed 100° F is rare. Highest temperatures of summer are associated with fair skies and westerly winds. Lower humidity escorted by northern winds about three times each month makes Tarrant County winters mild. Extreme cold periods are often short-lived.

Average length of the freeze-free period in the Tarrant County study area is 249 days. Average date of the last occurrence of temperatures reaching 32° F or below is 16 March. Average date of temperatures dropping to 32° F or below in the autumn is 21 November.

The Fort Worth area receives approximately 32 in of precipitation a year, the majority falling as rain. Highest amounts of rainfall occur during the months of April and May with most of the rain resulting from thunderstorms.

Average annual relative humidity varies from 47 percent at 6:00 P.M. to 76 percent at 6:00 A.M. (USDOC 1980). Snowfall is rare, with a measurable fall of 3.5 in occurring once during an average year. Windstorms occur during heavy thunderstorm activity.

Wind direction in Fort Worth is illustrated in Figure 5-14. Prevailing wind direction in the study area is from the south for 11 months during the year.



Scale: 1" = 10%

Numbers indicate % of time

SOURCE: ADAPTED FROM NOAA 1976.

FIGURE 5-14. ANNUAL AND SEASONAL PREVAILING WIND DIRECTIONS IN TARRANT COUNTY.

In January the wind is from the north. On an annual basis, prevailing winds are from the south to southeast 34 percent of the time. Average wind speed is 8.8 knots (10.1 mph), with the peak monthly average wind speed of 10.5 knots (12.0 mph) occurring in March, and the lowest monthly average wind speed of 7.3 knots (8.4 mph) occurring in August.

Mixing layer height, a meteorological parameter that is important in the determination of air quality, is defined as the height above the surface through which relatively vigorous vertical mixing occurs. Interpolated mixing layers for Fort Worth are shown in Table 5-10.

Atmospheric temperature inversions result from air near the earth being cooler than the air above. Inversion conditions cause a stable atmosphere and thereby reduce mixing layer height. Inversions can be caused by a number of factors, but always result in suppression of vertical motion and therefore restricted dispersion of pollutants and odor (Turk 1974). The percentage of time there is an atmospheric inversion in Fort Worth is presented in Table 5-11.

5.4.1.2 Air Quality

Ambient Air Quality. The project region is located in Federal Air Quality Control Region (AQCR) 215. For state purposes of identification, the project is in Texas Air Control Board (TACB) Air Quality Control Region 8 (Metropolitan Dallas - Fort Worth). National ambient air quality standards and additional state standards are listed in Tables 5-12 and 5-13, respectively.

Concentration of particulates at 18 of 27 stations in and around the project area were in violation of the $260/ugm^3$ primary 24-hour particulates national ambient air quality standard. The conclusion was based on data obtained from the National Aeromatic Data Bank's yearly frequency distribution for Tarrant County (TACB 1978). Another study conducted by the Texas Air Control Board, in compliance with requirements for state implementation plans, concluded that Tarrant County was a "non-attainment area" (NAA) for total suspended particulates. Major causes of non-attainment in all NAA's are: (1) monitors located too close to heavily traveled roads and/or too close to the ground; and (2)

TABLE 5-10. INTERPOLATED MEAN MIXING LAYER HEIGHTS AT FORT WORTH, TEXAS

Season	Morning Mixing Heights (ft)	Afternoon Mixing Heights (ft)
Winter	1,500	3,400
Spring	1,900	4,800
Summer	2,300	6,400
Autumn	1,500	4,800
Annual	1,600	4,900

SOURCE: HOLZWORTH 1972.

TABLE 5-11. INTERPOLATED ATMOSPHERIC INVERSION FREQUENCY AT FORT WORTH, TEXAS (BASE OF INVERSION IS BELOW 500 FEET ABOVE THE STATION ELEVATION)

Season	Percentage of Time
Winter	35%
Spring	24%
Summer	27%
Autumn	38%
Annual	29%

SOURCE: HOSLER 1961.

TABLE 5-12. NATIONAL PRIMARY AND SECONDARY AMBIENT AIR QUALITY STANDARDS

Pollutant	Type of Standard	Averaging Time	Frequency Parameter	Concentration	
				ug/m^3	ppm
Sulfur Oxides (as sulfur dioxide)	Primary	24 hr	Annual maximum[a]	365	0.14
		1 yr	Arithmetic mean	80	0.03
	Secondary	3 hr	Annual maximum[a]	1,300	0.50
Particulate Matter	Primary	24 hr	Annual maximum[a]	260	—
		24 hr	Annual geometric mean	75	—
	Secondary	24 hr	Annual maximum[a]	150	—
		24 hr	Annual geometric mean	60[b]	—
Carbon Monoxide	Primary and Secondary	1 hr	Annual maximum[a]	40,000	35.00
		8 hr	Annual maximum[a]	10,000	9.00
Ozone	Primary and Secondary	1 hr	Annual maximum[a]	235	0.12
Hydrocarbons (nonmethane)	Primary and Secondary	3 hr (6 to 9 A.M.)	Annual maximum[a]	160[c]	0.24[c]
Nitrogen Dioxide	Primary and Secondary	1 yr	Arithmetic mean	100	0.05
Lead	Primary and Secondary	3 mo	Arithmetic mean	1.5	—

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a. Not to be exceeded more than once per year.

b. As a guide to be used in assessing implementation plans for achieving the annual maximum 24-hour standard.

c. As a guide in devising implementation plans for achieving oxidant standards.

SOURCE: EPA 1981d.

TABLE 5-13. AMBIENT AIR QUALITY STANDARDS ADOPTED BY TEXAS IN ADDITION TO THE NAAQS.

PARTICULATE	
Rule 105.21	100 micrograms per cubic meter averaged over any five consecutive hours
Rule 105.22	200 micrograms per cubic meter averaged over any three consecutive hours
Rule 105.23	400 micograms per cubic meter averaged over any one hour period
SULFUR DIOXIDE	
Rule 201.07 - in Galveston & Harris Counties only	.28 ppm averaged over any 30 minute period
Rule 201.08 - Jefferson & Orange Counties only	.32 ppm averaged over any 30 minute period
Rule 201.09 - Statewide	.4 ppm averaged over any 30 minute period
HYDROGEN SULFIDE	
Rule 203.1 for residential, business or commercial	.08 ppm averaged over any 30 minute period
Rule 203.2 otherwise	.12 ppm averaged over any 30 minute period
SULFURIC ACID	
Rule 204.1	15 micrograms per cubic meter averaged over any 24-hour period 50 micrograms per cubic meter averaged over a one-hour period more than once during any consecutive 24-hour period 100 micrograms per cubic meter maximum at any time
GASEOUS INORGANIC FLUORIDE COMPOUNDS	
Regulation III, Section III, A3b - calculated as HF	6 ppb averaged over 3 consecutive hours
BERYLLIUM	
Regulation III, Section III, B2	.01 microgram per cubic meter over any 24-hour period

SOURCE: HARTZOG 1982.

fugitive dust from agriculture tilling activities; the wind erosion of arid lands; dirty paved streets and parking lots; unpaved streets, parking lots, and alleys; construction activities and industrial processes (TACB 1979).

Photochemical oxidant (ozone) levels were monitored at three different sites in Tarrant County. All three sites were in violation of the 0.08 ppm (160 ug/m^3) 1-hour photochemical oxidants national ambient air quality standard. Monitoring site data were obtained from the National Aerometric Data Bank, and studies conducted by the Texas Air Control Board all produced evidence that Tarrant County was classified as an NAA.

On 3 February 1983, EPA published in the Federal Register (48 FR 4972) a proposed action regarding certain areas that the agency does not believe will be able to demonstrate compliance with ambient air quality standards by 31 December 1982, as required. One of the areas listed as not expected to meet the 31 December 1982 deadline was Tarrant County, for the pollutant ozone.

Finalization of this proposed action would invoke certain statutory consequences in an area. Specifically, a ban on construction or modification of major stationary sources emitting the pollutant for which the area is nonattainment would be imposed. The area also may be subject to a suspension of certain federal grants.

Since a sewage treatment plant is normally not a major source of any air pollutant, a construction moratorium typically would not impact proposed construction of a sewage treatment plant. However, a restriction on Federal grants may impact the construction of a sewage treatment plant since Section 316(b) of the Clean Air Act allows the Administrator to withhold, condition, or restrict sewage treatment grants. The 3 February 1983 Federal Register action did not propose this funding sanction, but rather requested comment on those circumstances where imposition of this funding restriction may be appropriate. If EPA decides to impose the 316(b) sanction, a notice will be published in the Federal Register.

Carbon monoxide (CO) levels have been monitored at three sites in Tarrant County from 1976-1979. The CO concentration level is below the national ambient air quality standard. The highest average level of CO ever recorded in an 8-hour period was 7.3 mg/m^3 and in a 1-hour period it was 10.5 mg/m^3, both of which occurred in 1978.

Data for nine sulfur dioxide monitoring stations located in Tarrant County indicate no stations in violation of the national ambient air quality standard for sulfur dioxide. Nitrogen oxide levels also were found in compliance with national ambient air quality standards.

Emission Sources. Point sources are defined as any stationary source which, if uncontrolled, would emit 100 tons per year of any criteria pollutant. Most point sources are industries. Area sources are generally smaller, more distributed sources. Tarrant County has a variety of sources of air pollutant emissions. Major industrial point sources are the cement, chemical, power, and cotton mill industries. Other non-point sources such as highway vehicles also contribute significant tonnages of air pollutants. A Federal Prevention of Significant Deterioration (PSD) permit would not be required for expansion of the Village Creek WWTF since the facility is not considered to be a major stationary source.

5.4.1.3 Odor

Currently, major sources of odor at the Village Creek WWTF are the pretreatment, primary treatment, sludge thickening, sludge digestion, and sludge dewatering (drying beds) facilities. Table 5-14 indicates locations in a wastewater system where odors typically may develop.

Odors are one of the most serious environmental concerns surrounding the Village Creek WWTF. The plant received 451 odor complaints from January 1982 through December 1982. Distribution of these complaints by month for the years 1980, 1981, and 1982 is presented in Table 5-15. Odor complaints are handled under the state's nuisance provision [general rule 101.4 (131.01.00.005)] 1981).

During the weeks of 27 September 1982 and 10 January 1983, the TACB hydrocarbon sampling van was at the Village Creek Sewage Treatment Plant in

TABLE 5-14. LOCATIONS IN WASTEWATER SYSTEMS WHERE ODORS TYPICALLY DEVELOP.

Location	Waste-water	Grit	Screen-ings	Scum	Sludge	Waste Air	Slime on Walls	Organic Dirt on Surfaces	Sludge Deposits	Dark or Porous Walls	Chemical Spills	Eddy or Short-Circuited Areas
Gravity sewers	x					x	x		x			
Force mains	x					x	x		x			
Pumping stations:												
Wet wells	x			x			x	x	x	x	x	x
Dry wells	x							x		x		
Stilling wells				x			x	x	x	x		x
Grit chamber	x	x		x	x		x	x				
Screens	x		x				x	x	x	x		
Grease, screenings and grit handling		x	x	x	x		x	x				
Equalization tank	x			x	x	x	x	x	x			
Primary settling basin:	x			x	x		x	x	x	x		x
Sludge transfer					x			x	x	x		
Scum transfer	x			x			x	x		x		
Chemical addition						x	x				x	
Aeration tanks	x					x			x			x
Trickling filters	x			x		x	x	x	x	x		x
Ponds	x			x				x	x			
Biodisks						x	x	x		x		
Final settling basins	x			x	x	x	x	x	x	x	x	x
Granular media filters	x						x	x	x	x		
Sludge pumping					x			x	x	x		
Sludge thickening				x	x	x	x	x	x	x		
Sludge storage				x	x	x	x	x	x	x		
Sludge conditioning				x	x	x	x	x	x	x	x	
Sludge dewatering	x			x	x	x	x	x	x	x	x	
Sludge digestion					x	x	x	x	x	x		
Heat treatment					x	x	x	x	x			
Process sidestream handling	x				x		x	x	x			
Septage handling	x				x	x	x	x	x	x	x	
Land irrigation	x					x	x	x	x	x		
Effluent structure	x					x	x	x		x	x	
Ventilation system						x		x	x	x		
Sumps for drainage	x			x	x		x	x		x	x	
Channels for drainage	x			x			x	x	x	x	x	x
Flow distribution structures				x			x	x	x	x		x
Chemical contact tanks						x	x	x	x	x	x	x
Carbon columns							x	x		x	x	
Sludge incineration						x		x				
Sludge composting					x	x	x	x	x	x	x	
Sludge spreading					x							

SOURCE: TASK FORCE ON ODOR CONTROL 1979.

TABLE 5-15. YEARLY DISTRIBUTION OF ODOR COMPLAINTS CONCERNING THE VILLAGE CREEK WWTF

MONTH	1980	1981	1982
January	17	40	120
February	10	25	11
March	10	20	11
April	54	21	8
May	47	23	8
June	10	5	7
July	8	0	8
August	9	43	29
September	24	38	100
October	61	4	120
November	46	7	11
December	30	2	18
TOTAL	326	228	451

SOURCE: BOYD 1983.

Arlington sampling for odorous sulfur compounds. Testing was requested by TACB Region 8 in response to the numerous nuisance odor complaints of residents near Village Creek WWTF.

On-site analyses were conducted at the primary clarifiers, the secondary clarifiers, and the drying beds during the September sampling. During January the sampling occurred at the primary clarifiers and at three sites in the residential area south of Village Creek WWTF. Five charcoal tube samples also were obtained during September: two from the primary clarifiers, and one each from the secondary clarifiers, the centrifuges, and the drying beds. None captured pollutants in sufficient concentration to be detected. An attempt to obtain additional tube samples during January failed due to equipment malfunction (TACB 1983).

Only during the September sampling at the primary clarifiers were pollutant compounds present in sufficient quantities to be detected (Minimum Detection Limit [MDL] was 5 ppb.). Between 10:40 p.m. on 28 September 1982 and 11:00 a.m. on 29 September 1982, sulfur containing compounds were detected 85% of the time (35 of 41 samples) and hydrogen sulfide (H_2S) was identified as a constituent of these compounds 59% of the time (24 of 41 samples). From 11:25 to 1:35 p.m. on 29 September 1982 no sulfur compounds were detected at the primary clarifiers (9 samples). During sampling at the drying beds from 10:45 p.m. (29 September) to 2:15 p.m. (30 September) (59 samples), and at the secondary clarifiers from 12:00 midnight (30 September) to 9:45 a.m. (1 October) (39 samples), no sulfur compounds were detected (TACB 1983).

No sulfur compounds were detected during the Januray sampling. Sampling was conducted at the primary clarifiers from 11:30 p.m. (10 January) to 2:15 p.m. (11 January) (54 samples). Sampling was also conducted at three locations in a residential area south of the plant from 11:30 p.m. (11 January) to 9:45 a.m. (12 January) (total of 39 samples).

The highest concentrations of total sulfur and H_2S encountered were 0.452 ppm and 0.135 ppm, respectively. Since the threshold limit value (TLV) of H_2S (i.e., the concentration above which adverse health effects begin to occur) is 10 ppm, exposure to these levels should not constitute a risk to public health. However, because the odor threshold of H_2S (i.e., the concentration above which odors become perceptable to person of average senses) is 0.03 ppm these levels may cause nuisance conditions (TACB 1983).

Landfills also are generally recognized as sources of odor. The Arlington landfill and the Tarrant Sanitation Company landfill (both of which are located within 5 mi of the Village Creek WWTF) have not been identified by the public as sources of offensive odors, but still may generate undesirable odors occasionally.

The proposed land application area around Saginaw and the land treatment area around Mustang Creek are both rural areas with scattered population centers. Minor odors associated with an agricultural environment are common throughout the area.

5.4.1.4 Noise

In 1972, Congress passed legislation directing EPA to examine uniform levels of environmental noise exposure necessary to protect the public health and welfare. Information on general ambient sound levels in the project region is not available. However, an environmental noise assessment was performed in Grand Prairie, 6 miles east of the Village Creek WWTF. This study was a joint project of the City of Grand Prairie and the Texas State Department of Health. The study delineated two major noise generators in the Grand Prairie area, the LTV Aerospace Corporation and the Dallas Naval Air Station. However, noise levels were within a 5 dBA margin of safety allowed by EPA. A less serious problem area was identified 3 to 4 miles from the southern boundary of the Dallas-Fort Worth regional airport.

There have been no noise surveys conducted in the vicinity of the Village Creek WWTF. Land use around the Village Creek WWTF is predominantly residential. Noise levels adjacent to and surrounding the Village Creek WWTF do not significantly affect the residential neighborhoods. Dense vegetation and land contours decimate the sound of the environs located within 1000 feet of the facility. Typical L_{dn} noise levels for a suburban residential development range from 45 to 55 dBA (National Research Council 1977). The only noise complaint about the operation of the Village Creek WWTF was related to the outside speakers for the public address system. The number of speakers has been reduced and there have been no more noise complaints.

Land use in the Mustang Creek land treatment area (Site 3) and the sludge disposal target area around Saginaw (Site 1) is predominantly agricultural. Noise levels associated with agricultural activities vary widely depending on the activity taking place at any given time.

The City of Fort Worth has an ordinance against unreasonably loud noises which cause distress, discomfort or injury to persons of ordinary senses in the immediate vicinity. This ordinance also prohibits any noise of such character, intensity and/or continued duration which substantially interferes with the comfortable enjoyment of private homes by persons of ordinary senses (Fort Worth City Code -Chapter 27, Section 27-18). There are no additional local ordinances that would apply to the Village Creek WWTF (Webb 1981). At present, neither Tarrant County nor the State of Texas has established noise control guidelines or regulations.

5.4.2 Environmental Consequences of the No Action Alternative

5.4.2.1 Air Quality

If the plant were overloaded as a result of the no action alternative, the wastewater and sludge would not receive thorough treatment and thus the degree of pathogen kill would be reduced. This condition would increase the potential for aerosols generated at the Village Creek WWTF to contain pathogenic organisms, which potentially could cause an increase in disease in plant workers and private citizens residing nearby (see Section 5.4.3.1). There also would be a slight decrease in fugitve dust emissions from the drying beds since sludge would not remain on the beds long enough to be dried thoroughly.

If Fort Worth continued to grow as expected, increased emissions from the increased population would occur regardless of whether or not this project is completed. However, if Fort Worth's growth is stifled due to lack of adequate wastewater treatment capacity, area emissions potentially would remain constant or be reduced.

5.4.2.2 Odor

If the Fort Worth wastewater treatment system is not expanded and Fort Worth continued to grow as planned, the WWTF would be overloaded by about 1985. This situation would result in severe odor problems, especially with the sludge handling system. Sludge would only be partially digested and therefore would generate significant odors throughout the plant, and especially on the drying beds. The final method of disposal would most likely be in a landfill. The sludge would cause significant odors at the landfill, as well as along the haul route (if open trucks are used).

5.4.2.3 Noise

The sound environment should remain largely unchanged from existing conditions if no action is taken. If the no action alternative was chosen, sludge would be disposed of in a landfill. Since there are no sensitive receptors along the route which would be followed by trucks transporting sludge to the landfill, there would be minimal noise effects.

5.4.3 Environmental Consequences of Alternative 1

5.4.3.1 Air Quality

Small droplets of wastewater which could contain pathogens (bacterial or viral) are emitted into the air at wastewater treatment plants. These droplets evaporate very raidly to yield small droplet nuclei known as aerosols. A major source of aerosols for this alternative includes the aeration basins (i.e., activated sludge treatment units).

A number of epidemiological studies have recently been performed on workers at wastewater treatment plants and spray irrigation facilities, and on populations living adjacent to these sites. Data on health effects from the existing epidemiological studies do not show any correlation between airborne pathogenic microorganism levels at wastewater treatment plants and incidence of disease in treatment plant workers or in nearby populations (Majeti 1981). The following reasons have been suggested for this lack of correlation:

(1) Densities of specific pathogens in the aerosols were low, and were reduced rapidly with time and distance from the source.

(2) With a respiration rate of approximately one cubic meter per hour, a person would ordinarily inhale very few organisms unless constantly exposed for many hours.

(3) Exposure levels were below the minimum infective dose.

(4) Microorganisms in wastewater primarily affect intestines, whereas the route of exposure is respiratory. Proper surface receptor sites for the organisms may not have been available.

(5) Nonspecific immunity, which responds quickly to foreign substances, was capable of handling the few microorganisms inhaled.

(6) Exposed persons were probably in good health and better able to combat infection than would persons in poor to fair health.

(7) Infectious agents other than those checked may have caused an undetected infection (Pahren and Jakubowski 1981).

Fugitive dust would be generated during construction of the proposed facilities at the Village Creek WWTF. Impacts from this dust would be short-term and minimal. Dust also would be generated from the 60-acre stockpile used to store sludge before land application. Due to the relative size of the stockpile compared to the municipal landfill, dust generated by the stockpile would be minimal in comparison to dust generated by the landfill. The location of the stockpile probably would be in a sparsely populated rural area, thereby reducing effects of fugitive dust. Land application of sludge is a dusty operation; however, generation of dust is common in agricultural activities, and dust generated during sludge application would be within the normal range.

The Village Creek WWTF would be expanded to handle the expected population increase in the Fort Worth area. An increase in area source emissions would be associated with any increase in population. This increase in emissions would be expected to have a minimal effect on the air quality of the study area. Some increase in emissions from area and point sources is allowed in the State Implementation Plan (SIP). Increased emissions from the population growth would be expected to be well within allowable limits (Fowler 1982).

5.4.3.2 Odor

It is not possible to design and operate a completely odor-free sewage treatment plant. During normal operation of the plant, some odor would be generated. The impact of this odor is highly dependent on the sensitivity of individual receptors. During periods of system upset, odor would be more intense. The system can be disrupted by various causes including unusual characteristics of incoming sewage (e.g., heavy organic load or toxics), equipment malfunction, and/or improper operation. All feasible engineering efforts that would eliminate or ameliorate odors have been evaluated in the facilities plan for the proposed expansion.

As part of the expansion from 96 mgd to 137 mgd, pretreatment, primary treatment, sludge thickening, sludge digestion, and sludge dewatering facilities where odors are not already controlled would be covered and the exhaust air from these housings would be scrubbed. Alternately, chemical control of odors may be used if proven cost-effective and efficient for odor control. The sludge drying beds would not be used on a daily basis, thus odors from the beds would be substantially reduced.

After dewatering, sludge would be stockpiled at an uncovered 175-ac site (60-ac stockpile plus buffer zone) located somewhere in the 60,000-ac sludge disposal target area (Site 2). Detention time at this stockpile would be long enough for further drying of the sludge. It is anticipated that this stockpile would be located adjacent to a municipal refuse landfill. Odors would be generated at this 60-ac stockpile; however, in comparison to the 850-acre municipal landfill, odors from the sludge stockpile would be minimal. It is expected that the stockpile and the adjacent landfill would be located in a sparsely populated rural area, thereby reducing impacts of the odor. The 60,000-ac sludge disposal target area (Site 2) is projected to remain in rural/agricultural use through year 2005. However, if the area were to develop with residential/commercial facilities during the planning period, impacts of odor on residential developments near the sludge stockpile could be substantial.

5.4.3.3 Noise

Short-term increases in ambient noise levels would result from construction of the proposed expansion of the WWTF. The nearest residence to the proposed construction is approximately 1,200 feet. Construction would primarily take place during the day during normal working hours, and due to the short time frame involved, impacts from the increased noise level would be minimal.

Operation of the expanded Village Creek WWTF would not significantly affect the noise environment of the surrounding area. Major noise producing equipment would be enclosed, thereby significantly reducing noise outside of the housing. There currently are no noise complaints associated with operation of the Village Creek WWTF, and the proposed expansion would not significantly increase ambient noise levels.

Noise resulting from stockpiling sludge and from farmers picking up sludge would be minor in comparison to noise associated with the adjacent municipal landfill. The stockpile and municipal landfill would be located in a sparsely populated rural area, and the likelihood of sensitive receptors being located near the stockpile is slight.

Approximately 25 to 30 round trips per day of sludge would be made to the stockpile. The truck route would follow a plant road to Bedford Road, thence to SH 183, thence to IH 820, thence to IH 35W, thence to US 81 to the stockpile area. There are no sensitive receptors located along this route, therefore, noise generated by the trucks would not have a significant noise effect.

5.4.4 Environmental Consequences of Alternative 2A

5.4.4.1 Air Quality

Potential for generation of pathogenic aerosols has been discussed in Section 5.4.3.2. In addition, there also is a slight possibility for pathogenic aerosols to be released from the sludge in the landfill. As was discussed in Section 5.4.3.2, pathogenic aerosols are not expected to adversely affect public health.

Fugitive dust resulting from construction of the proposed expansion of the Village Creek WWTF has been discussed in Section 5.4.3.1. In addition, there would be some dust generated from the landfill site; however, very little of the dust generated at the landfill would be attributable to the sludge, which is only 40 to 60 percent solids. Few sensitive receptors would exist in the sparsely populated area.

Increased emissions resulting from population growth would be as discussed in Section 5.4.3.1.

5.4.4.2 Odor

Odor associated with expansion of the Village Creek WWTF is described in Section 5.4.3.2. After dewatering at the Village Creek WWTF, sludge would be disposed of at a new municipal landfill located somewhere in the 60,000-ac sludge disposal target area. Exact location of the landfill has not been determined by the Fort Worth Department of Public Works, Sanitary Division. Sludge would constitute approximately 10 to 30 percent of the total material disposed of in the landfill, and odors would be generated from the landfill regardless of whether or not it is used for sludge disposal. The addition of sewage sludge may increase odors but the increase should be minimal and insignificant. It is beyond the scope of this EIS to evaluate impacts associated with the municipal landfill. However, it is expected that the landfill would be located in a sparsely populated rural area, and thus the likelihood of sensitive receptors being located near the landfill is slight.

5.4.4.3 Noise

Operation and construction noise generated at the Village Creek WWTF has been discussed in Section 5.4.3.3. Noise generated at the landfill site by 25 to 30 trucks per day hauling sludge would be minimal in comparison to the large number of trucks carrying municipal waste to the landfill. The route to the landfill would be indentical to the route to the stockpile site, therefore the noise impacts caused by transportation of sludge would be the same as those presented in Section 5.4.3.3.

5.4.5 Environmental Consequences of Alternative 2B

5.4.5.1 Air Quality

Potential for generation of pathogenic aerosols has been discussed in Section 5.4.3.1. In addition, there also is a slight possibility for pathogenic aerosols to be released from the sludge in the landfill. As was discussed in Section 5.4.3.1, pathogenic aerosols are not expected to adversely affect public health.

Fugitive dust resulting from construction and operation of the expanded Village Creek WWTF would be the same as for Alternative 1, discussed in Section 5.4.3.1. Moderate amounts of fugitive dust also would be generated at the landfill, primarily from digging and placing cover soil. Dust generated in the low floodplain area would not be expected to affect residential areas located on the hills above the Village Creek WWTF.

Increased emissions from population growth would be the same as for Alternative 1, described in Section 5.4.3.1.

5.4.5.2 Odor

Odor associated with expansion of the Village Creek WWTF would be the same as for Alternative 1, described in Section 5.4.3.2. Pumping liquid sludge through a pipeline to the 500-ac landfill site (Site 2) would not generate odors unless a pipeline break occurred. Sludge dewatering would be accomplished by belt press units housed inside a closed building. Odors would be generated by both sludge and liquid filtrate during the dewatering process. However, the dewatering building would be enclosed, and exhaust air from the dewatering building would be scrubbed. Dewatered sludge would not typically produce odors during hauling or stockpiling efforts. Sludge placed in the landfill would be covered daily with 0.5 to 2 ft of soil cover, thus odors from landfilling should be minimal. Odors generated in the vicinity of the landfill potentially would emanate more from the Tarrant sanitation landfill adjacent to Site 2 than from the proposed sludge-only landfill. Closest sensitive receptors are residential homes located approximately 2 mi southeast of the proposed sludge landfill site. Odors may reach these areas particularly during cold, wet winter months when prevailing winds are from the north (approximately 12.7 percent of the time - see Figure 5-14).

The City's proposed plan also would involve experimental composting and landspreading activities on the 500-ac disposal site, both inside and outside of the diked landfill area. Substantial odors potentially would be generated when sludge deposited in the floodplain becomes wet during and following flood conditions.

5.4.5.3 Noise

Construction and operation noise generated at the expanded Village Creek WWTF would be the same as discussed in Section 6.4.3.3. Noise generated by large earthmoving equipment during construction of the sludge pipeline and landfill would be moderate, but would be of a short-term duration. Noise generated during operation of the landfill would be minimal. This is because all dewatering equipment would be enclosed, and the landfill equipment would operate down in disposal cells inside of flood protection levees. Noise effects to nearby residential areas would be noticeable during construction of Alternative 2B but virtually non-existent during operation.

5.4.6 Environmental Consequences of Alternative 3

5.4.6.1 Air Quality

Impacts from pathogenic aerosols at the Village Creek WWTF would be the same as those presented in Section 5.4.3.1. Spray irrigation, which would be used at the Mustang Creek site, also would be a source of aerosols. Irrigation rigs would spray downward at a low pressure to reduce formation of aerosols. Lack of population in the area directly surrounding the irrigated fields would result in fewer people coming into contact with the aerosols generated. As was discussed in Section 5.4.3.1, there is no conclusive evidence linking exposure to wastewater aerosols and human disease.

Fugitive dust generated by construction and operation of the Village Creek WWTF expansion would be as discussed in Section 5.4.3.1. Fugitive dust would be generated by construction of the pipeline, aerated lagoons, and the storage reservoir. Impacts would be short-term and insignificant. Substantial amounts of fugitive dust would not be generated from operation of the land treatment system at Mustang Creek.

Increased emissions from population growth and the resulting impacts would be as presented in Section 5.4.3.1.

5.4.6.2 Odor

Odor generated at the Village Creek WWTF and the impacts resulting from this odor would be similar to those described in Section 5.4.3.2. The magnitude of the effects potentially would not be as great, since 96 mgd would be treated at the Village Creek WWTF instead of the 137 mgd associated with Alternative 1.

In addition to odor generated at the Village Creek WWTF, there also will be odor generated at the pump stations along the pipeline to Mustang Creek. At their closest point, these pump stations are located 1/8 to 1/4 mi from the nearest sensitive receptor (e.g., residence). However, these lift stations would not have a major effect on the sensitive receptors because the lift stations would be enclosed, and compressed oxygen would be added to the sewage at each lift station.

The Mustang Creek land treatment site (Site 3) would contain an aerated lagoon (75 acres), a storage reservoir (450 acres - high water surface area), and irrigation facilities, all of which would be potential sources of odor. The most intense odor would be generated from the aerated lagoons, with less odor resulting from the reservoir and irrigation process. During periods of rainy weather and during harvest, detention time of the wastewater in the reservoir would increase to a maximum of 90 days, allowing stratification to occur. This situation could result in anaerobic conditions forming in the bottom layers of the reservoir, thereby increasing generation of odors. Some odor also may result from irrigation, particularly if wastewater is allowed to pond in fields. Underdrains would be installed in those areas that have a tendency to allow standing water. This mitigative measure would greatly reduce the probability of significant odors being generated from the irrigation process.

Landowners who own part of the land on which the storage reservoir potentially would be constructed as well as land to the north and east of the reservoir have plans to sell their land in small acreage tracts for residential development. They currently have sold a small percentage of the land, and there are mobile homes located on a few of these tracts. In the future, they hope to sell the rest of their land to complete development. It is probable that existing mobile homes and future developments would be negatively affected by odor from the aerated lagoons and storage reservoir. The wind blows from the south-southeast approximately 45 percent of the time annually, and less than 10 percent from a westerly direction. Mitigative measures such as expanding the buffer zone or relocating the aerated lagoon and storage reservoir could be considered to reduce or eliminate odor impacts to the north and east.

Other than planned development to the north and east, the nearest residence is approximately 1/8 to 1/4 mi from the treatment site and is owned by one of the landowners who own the land where the aerated lagoon and reservoir would be located. It is expected that this residence would be affected by odor; however, the landowner would be aware of the potential for odor before selling.

5.4.5.3 Noise

Generation of noise and resulting impacts caused by construction and operation of the Village Creek WWTF expansion would be as discussed in Section 5.4.3.3. Construction of the pipeline would generate noise which could affect sensitive receptors. Since the pipeline would mostly follow existing pipeline, highway, and railroad rights-of-way, land clearing with large equipment would not be necessary.

The majority of noise would come from digging trenches, laying pipe, and covering pipe. An approximately 1/8 to 1/4 mi buffer zone on either side of the pipeline would help to attentuate the noise. There is no buffer zone where the pipeline transects a mobile home park, therefore, construction noise impacts would affect residences of this park. Construction noise impacts are short-term in nature and are not considered as significant as long-term operational impacts. Construction would occur during the day to help ameliorate adverse effects.

Noise also would be generated from construction of the aerated lagoon and storage reservoir. There are no sensitive receptors that would be significantly affected by this noise. There would be a slight increase in noise levels in the vicinity due to operation of the treatment facilities. This increase would not have a significant adverse effect. Irrigation rigs would operate on electrical power, which would produce minimal sound.

5.5 BIOLOGICAL RESOURCES

5.5.1 Existing Conditions

The project area lies in the Texan Biotic Province as defined by Gould (1969). The Province generally is considered an ecological transition zone between grasslands to the west and pine-hardwood forests to the east (Blair 1950). The significance of this ecological transition is that a mixture of prairie and eastern forest plants as well as many eastern forest birds and mammals reach the western limit of their range, and some prairie species reach the eastern extension of their habitat.

5.5.1.1 Terrestrial Biota

Vegetation. Existing vegetation in the project area occurs primarily as a result of past and present land uses. Few natural areas remain, as most native vegetation has succumbed to the activities of man.

The project area approximates the common border of two regional vegetation zones -- the Blackland Prairie to the east, and the Eastern Cross Timbers to the west (Gould 1962). Vegetation differences between these two regions are largely the result of differences in soils and topography. Dark calcareous clays and level to gently rolling topography characterize the Blackland

Prairie, while light sandy soils and rolling hills are typical of the Eastern Cross Timbers. Only remnants remain of presettlement vegetation in these regions. The original Andropogon - Stipa - Aristida tall grass association of the Blackland Prairie has been almost entirely replaced by cultivated species and associated weeds. Similarly, both prairie and oak components characteristic of the Eastern Cross Timbers have been highly disturbed by cultivation and ranching practices (Gould 1962; Tharp 1926).

Forests in the Blackland Prairie are restricted to river bottoms and typically form narrow bands of flood tolerant woody plants (Teskey and Hinckley 1977). Tree species differ markedly from those found in sandy soils of the Eastern Cross Timbers [e.g., post oak, (*Quercus stellata*) and blackjack oak, (*Quercus marilandica*)], with midwestern and eastern species that prefer calcareous soils being more prevalent (Shinners 1958). Examples of these species include the cedar elm (*Ulmus crassifolia*), black walnut (*Juglans nigra*), and ashes (*Fraxinus* spp).

A high level of past and present human disturbance, including lumbering, quarry activities, and urban development typify the project area. Patches of floodplain forest (mostly second growth) remain, but most of the undeveloped area is recently disturbed, with numerous species of annual and perennial weeds abundant. The variation in the condition and species composition of existing vegetation primarily reflects the history of disturbance and proximity to watercourses.

Major Vegetation Cover Type. A variety of disjunct land cover types occur in the project area. Along major streams such as Village Creek, Big Fossil Creek, and the West Fork of the Trinity River some *bottomland forest* as described by Tharp (1926) and Winkler (1915) occur. This is really the only predominant forested area along floodplains. Along smaller tributary streams and channelized streams (ditches) a *streamside* vegetation type exists.

Cropland also makes up a large acreage of the project area. Minor cover types in the project area include *mesquite groves* and the *oak/elm forest*, *water*, *developed* (urban or industrial) and *disturbed areas* (dumps, quarries, etc.)

Bottomland Forest. This cover type is an important natural vegetation unit in the project area. It consists of patches and belts of flood tolerant woody vegetation located immediately adjacent to stream channels. This type is found along the banks of major streams such as the West Fork of the Trinity River, Village Creek, and Big Fossil Creek.

Dominant overstory species of this cover type include green ash (*Fraxinus pennsylvanica*), cedar elm, hackberry (*Celtis occidentalis* and *C. laevigata*), and black willow (*Salix nigra*). Distribution of dominant species in this type are related to the history of natural and/or human disturbance of specific areas. These species are typical of a later successional stage of development (Curtis 1959) and are most abundant on the banks of the West Fork of the Trinity River and along Village Creek.

Most of the trees in this type are less than 40 feet in height, indicating the area was cut in the mid-1900's. Low relative abundance, scattered distribution, and inferior forms of bottomland species such as shumard oak (*Quercus shumardii*), bur oak (*Quercus macrocarpa*), white ash (*Fraxinus americana*), and black walnut suggest a history of selective cutting for more valuable fuel and lumber species.

Other common species of the generally dense understory are hawthorn (*Crataegus* sp.), Chinaberry (*Melia azedarach*), ligustrum (*Ligustrum* spp.), swamp privet (*Forestiera acuminata*), and soapberry (*Sapindus drummondi*).

Many vine species are present in this type. Greenbrier (*Smilax sp*.) is the most abundant vine, however, wild grape (*Vitis sp*.) also is common. Ground cover is dominated by wild rye (*Elymus virginicus*), perennial grasses, and low creeping shrubs such as coralberry (*Symphoricarpos orbiculatus*) and dewberry (*Rubus trivialis*). Wild rye forms a dense mat throughout much of this type with occasional patches of other grasses, sedges, and forbs.

Streamside Forest. This cover type is somewhat interspersed with the bottomland type; however, because of its more distant location from major streams the vegetation present must be flood tolerant. Dominant overstory species include primarily cottonwood (*Populus deltoides*). Cottonwood is a pioneer species especially common in recently disturbed sites and is a fast growing species intolerant of shade. It is joined or replaced by green ash, American elm, and hackberry on more stable substrates.

In areas dominated by a black willow - cottonwood overstory, the understory is composed primarily of young individuals of these two species, as well as elderberry (Sambucus canadensis) and rough-leaved dogwood (Cornus drummondii). Soapberry, swamp privet, and saplings of cedar elm, hackberry, and green ash are the most abundant components of areas with more developed canopies. Greenbriar is the most ubiquitous vine species.

Weedy Field. This cover type is of large areal extent in the project area. Numerous species of herbaceous cover and a few woody pioneer species compose vegetation of this type and are evidence of recent disturbance.

Areas of most recent disturbance are characterized with species such as Aster spp., sunflower (Helinanthus annuus), Johnsongrass (Sorghum halapense), and giant ragweed (Ambrosia trifida). The sunflower and Johnsongrass are abundant on drier areas, while Aster spp. and ragweed are more abundant in wet areas.

Weedy fields of later successional stages include species such as switch grass (Panicum virgatum), buffalo grass (Buchloe dactyloides), and little bluestem (Andropogon scoparius). In addition, some field areas of former pasture also exist. These areas contain Bermuda grass (Cynodon dactylon) and composites such as Aster spp. and goldenrod (Solidago spp.). In this vegetative cover type, black willow, cottonwood, rough-leaved dogwood, and willow baccharis (Bacharis salicina) are the more common woody invaders in wet areas, whereas cedar elm and osage-orange (Maclura pomifera) are most commonly found occupying drier areas.

A variety of cropland types exist in the project area. Tame pasture, predominantly Bermuda grass, and low crops (various grain crops) represent most of the acreage. Native trees such as hackberry and cedar elm occur in open patches along fence rows and field borders, as does greenbrier. Most other vegetation cover types that occur in the project area are of minimal acreage.

Wetlands. Wetlands are transitional areas between the aquatic and terrestrial zone that are sometimes wet and sometimes dry. Wetland types considered in this study are primarily those classified by the USCOE as wetlands (Figure 5-15).

Both forested and non-forested wetlands occur in the project area. In some areas the bottomland forest occurs in sloughs that are lower than surrounding areas. During periods of high rainfall and when streams outflow their banks, these areas fill and hold water. Common species include bottomland species such as cedar elm, hackberry, green ash, and swamp privet.

Non-forested wetlands are formed generally in the same manner as forested wetlands. Depressions adjacent to streams fill with rain or floodwater and hold water for several weeks after flood waters recede. These areas are similar in most respects along their margins to the weedy field type. However, the deeper sections of this wetland type contain species characteristic of wet areas such as burhead (Echinodorus rostratus), common buttonbush (Cephalanthus occidentalis), and a variety of sedges (Carex spp.) and rushes (Juncus spp.).

Wildlife. Over 400 species of terrestrial wildlife (amphibians, reptiles, birds, and mammals) are known to occur in the project area. The three basic habitat units represented in the project area -- aquatic (water), forest, and field -- provide adequate food and cover for a wide diversity of animal species.

Some 12 species of amphibians and 44 species of reptiles have ranges that include the project area (Conant 1975; Raun 1972; Thomas 1976). Common amphibians include the Blanchard's cricket frog (Acris crepitans) and the bullfrog (Rana catesbeiana). Common reptiles of wetlands and watercourses are the Mississippi mud turtle (Kinosternon subrubrum), red-eared turtle (Chrysemys scripta), diamond-backed water snake (Natrix rhombifera), and rough green snake (Opheodrys aestivus). Many of these species are dependent on the water/land interface for survival.

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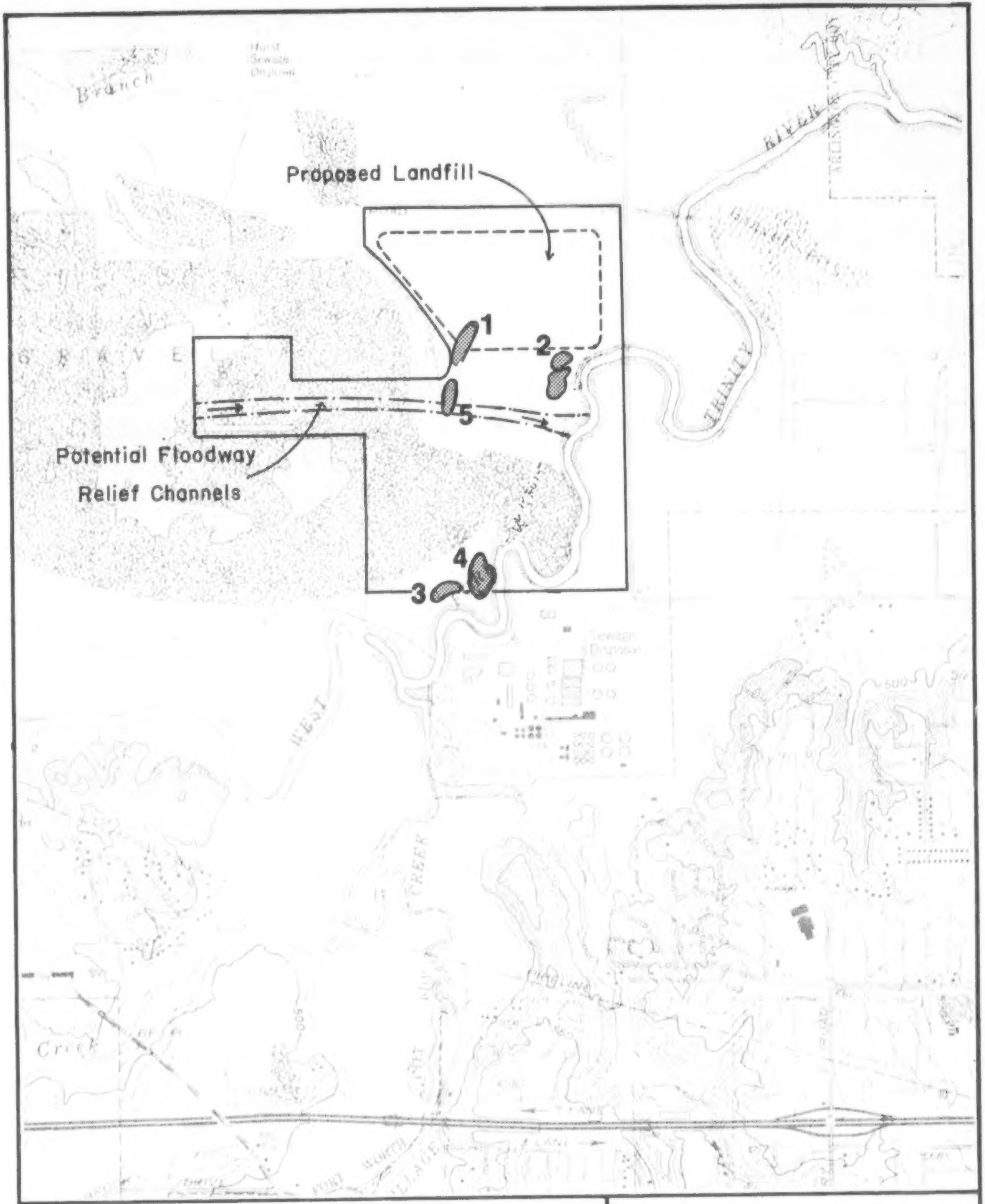

FIGURE 5-15. USCOE DESIGNATED WETLANDS IN THE VICINITY OF SITE 2 (SOURCE: ADAPTED FROM USCOE 1983b).

Over 300 species of birds are known to occur in the project area (Pulich 1961). A large majority of these species are migratory and occur in the project area only during a certain season(s), or move through the area during spring and autumn migrations.

Bobwhite (*Colinus virginianus*) and Mourning Dove (*Zenaida macroura*) are important game birds that occur in significant numbers in the project area. Both species are dependent on a mixture of forest and field habitats. Both also utilize croplands extensively. Waterfowl are the only other important game birds in the project area. They occur in varying numbers during spring and autumn migrations. Waterfowl occur in open water areas in wetlands adjacent to major streams. The present Village Creek WWTF and associated sludge drying beds also attract large numbers of birds, including several unique bird species.

Approximately 45 species of mammals range into the project area (Davis 1978). Common forest species include the opossum (*Didelphis marsupalis*), nine-banded armadillo (*Dasypus novemcinctus*), raccoon (*Procyon lotor*), and fox squirrel (*Sciurus niger*). The cottontail rabbit (*Sylvilagus floridanus*) is the most common field inhabitant. The fox squirrel is a game species, while the raccoon is considered a furbearer. Neither is hunted or trapped in appreciable numbers in the project area.

5.5.1.2 Aquatic Biota

Several major aquatic habitats occur in the project area. Lake Arlington, Lake Benbrook, Lake Worth, and Eagle Mountain Lake are the major lentic (standing water) habitats, while numerous (creeks) such as Village Creek, Big Fossil Creek, Little Fossil Creek, Sycamore Creek, Marine Creek, and the West Fork and Clear Fork of the Trinity River compose the major lotic (running water) habitats. Plants and animals that occur in these systems are important in maintaining the ecological balance of the system.

Relatively low phytoplankton populations which occur in the immediate Trinity River drainage in the Fort Worth/Dallas area are due primarily to excessive organic effluents and industrial dischargers (Murphy et al. 1971). Palmer

(1969) reported that most common phytoplankton in the area are indicative of gross organic pollution. Predominant taxa include chlorophytes (*Chlorella* sp., *Chlamydomonas* sp., and *Scendesmus* sp.). Chrysophytes, along with Euglenoids, also are present.

In the West Fork and the Trinity River proper (south and east of the project area) zooplankton is composed primarily of nonherbivorous species of protozoans such as *Arcella* sp. (McCollough and Camp 1973). This genera is composed of bacteria-eating ciliates versus algae-eating organisms.

Macroinvertebrates form the next major link in the food chain. These organisms subsist off various forms of plankton and detrital material and in turn are preyed on by fish, birds, and other top of the food chain consumers. Some macroinvertebrates live on the surface of stream and lake sediments, while others (benthic macroinvertebrates) live in the sediments.

Hellier (1972) found large populations of bivalves (*Quadrillo* sp.) and (*Truncilla* sp.) in shallows of the Trinity River upstream from Interstate Highway 35 just east of the project area. Other bivalves that have been collected in area streams include: *Corbicula* sp., *Obliquaria reflexa*, *Amblema rariplicata*, *Lampsilis* sp., *Quadrula* sp. (Trinity River Authority 1977), *Hydropsyche* sp., *Narpus* sp., and *Branchiura sowerbyi* (Petrick 1978).

Fish are the top consumers in the aquatic food chain. They are important due to their food value to man and other animals as well as their recreational value. Fish species of any definitive habitat are dependent on the quality and quantity of water available. Abundance and numbers of species of fish occurring in the West Fork of the Trinity River and major tributary creeks from Fort Worth east are limited due to poor water quality. Since these habitats support limited species of fish, the game species and associated sport fishing in the project area is associated with area reservoirs. These reservoirs and their tributary headwaters provide adequate water quality and habitat for more than 50 species of fish (Bonn 1956; Lamb 1957; Hellier 1972; Conner 1973) including most game fish species. Many of these species have the potential to occur in the West Fork and main stream of the Trinity River, but due to pollution are rarely observed. Rough fish such as the common carp

(Cyprinus carpio), long-nose gar (Lepusosteus cepedianum), and black bullhead (Ictalurus melas) are most commonly associated with the West Fork of the Trinity River.

5.5.1.3 Endangered or Threatened Species

The US Department of Interior Fish and Wildlife Service indicated that no endangered or threatened species occur in the project area (Beierman 1983 and Appendix A for correspondence).

5.5.2 Environmental Consequences of the No Action Alternative

5.5.2.1 Terrestrial Biota

Effects to terrestrial biota under this alternative are expected to be minimal. Some vegetation may be damaged if sewage overflows the present collection system onto adjacent areas, and wildlife and domestic animals come into contact with raw sewage. Higher numbers of insects and birds would be attracted such that both may occasionally be problems.

5.5.2.2 Aquatic Biota

Levels of nutrients and toxic materials (e.g., heavy metals) discharged to the West Fork of the Trinity River would further degrade already poor quality downstream of the Village Creek WWTF. Since many of the organisms occurring in this section are pollution tolerant, the net effect should be minimal. However, effects potentially would extend farther downstream.

5.5.3 Environmental Consequences of Alternative 1

5.5.3.1 Terrestrial Biota

Vegetation (predominantly weedy field) in the vicinity of the Village Creek WWTF (125 ac), northern stockpile pad (60 ac), and along existing collection line rights-of-way (196 ac) has been recently disturbed. Some weedy field cover would be eliminated by construction of Alternative 1, as would a few acres of second growth bottomland forest and other miscellaneous cover types. The loss of vegetation and resulting wildlife habitat would be insignificant. However, many birds are attracted to the existing sludge drying beds adjacent to the Village Creek WWTF. Elimination of the drying beds would eliminate the presence of many birds which are important to local bird watchers.

Numerous potentially toxic elements (metals, hydrocarbons, and bacteria etc.) occur in sludge generated at the Village Creek WWTF which would be spread at the land application area. Another important source of toxicants includes pesticides that would be used to protect crops against insect damage and intrusion of weeds resulting from sludge landspreading. Potential for adverse effects to wildlife from increased pesticide use on landspreading areas is greater than that from sludge application, although both could cause adverse effects if their application and build-up is not monitored.

5.5.2.2 Aquatic Biota

Construction activities at the Village Creek WWTF would cause short-term siltation and turbidity in the immediate downstream segment of the West Fork of the Trinity River and in areas immediately adjacent to collection pipeline construction. The segment of the West Fork of the Trinity River below the plant already is polluted from organic and industrial effluents, and the aquatic species present are for the most part pollution tolerant. On completion of Alternative 1, water quality of the Trinity River would improve and subsequently the biota in this segment would be expected to diversify.

Nutrients, metals, and pesticides accumulate in aquatic sediments as a result of industrial, agricultural, and domestic activities. Streams draining the stockpile and landspreading areas would receive increased levels of nutrients, metals, and pesticides. Nutrients in turn would accelerate eutrophication in affected waterbodies. The overall effect and rate of eutrophication would depend largely on the capacity of area soils and plants to utilize elements available in the sludge. Worst case situations would occur in ponds where nutrients would become trapped. In these systems, algae growth potentially would accelerate to a point so as to exclude most other organisms, including fish. Metals and pesticides may also build up in the food chain and cause physical changes such as loss of vigor or reduced reproduction capacity.

5.5.4 Environmental Consequences of Alternative 2A

5.5.3.1 Terrestrial Biota

The only notable adverse effect from Alternative 2A would be loss of vegetation. Loss of weedy field during Village Creek WWTF expansion (20 ac), sludge storage pad construction (40 ac), and collection pipeline construction (196 ac) would occur. Effects to terrestrial biota would be minimal. Bird watchers would be affected by loss of the drying beds, as in Alternative 1.

5.5.3.2 Aquatic Biota

Effects to area aquatic biota from factors associated with Alternative 2A would be similar to Alternative 1. The more notable effects include: turbidity and siltation in the West Fork of the Trinity River during expansion of the Village Creek WWTF and in streams adjacent to collection pipeline construction areas; increased diversity of aquatic biota due to improved water quality after expansion of the WWTF; and accelerated eutrophication and discharge of potentially toxic materials into streams draining the stockpile pad, with resulting adverse effects to aquatic biota.

5.5.5 Environmental Consequences of Alternative 2B

5.5.5.1 Terrestrial Biota

Expansion of the Village Creek WWTF and construction of a landfill across the West Fork of the Trinity River would result in loss of natural vegetation types and associated wildlife in the area, particularly where the proposed landfill and flood control channels would be constructed. Most notable losses would occur to weedy field and bottomland forest types. Approximately 4.4 acres of COE-designated wetlands occur interspersed in the vicinity of Site 2. Since these areas are sensitive, every effort should be made to minimize activites occurring in wetlands. Construction of the landfill and drainage channels in locations currently proposed would destroy (via direct excavation, dewatering, and/or altered drainage characteristics) some wetlands in the area (refer to Figure 5-15).

Elimination of the drying beds would affect local bird watchers, as in Alternative 1. The proposed landfill would likely attract insects and birds to the immediate area, a situation that potentially would cause some disturbance to local human residents as well as local wildlife but would be beneficial to local bird watchers.

5.5.5.2 Aquatic Biota

Adverse and beneficial effects to aquatic biota from Alternative 2B are expected to be similar to those discussed for Alternative 1.

Increased siltation and turbidity would result from the expansion of the Village Creek WWTF during flood relief channel construction and sometime thereafter. Aquatic habitats in the existing channel of the Trinity River would be altered due to new flow patterns associated with the proposed new channel. Effects of the proposed channelization on main channel aquatic inhabitants would not be substantial, since channel velocities and flood elevations would not change to a major degree. The new channel would provide a minor, beneficial amount of habitat for aquatic inhabitants. If concrete or rip-rap lining were provided, an additional, beneficial diversity of habitat would result.

5.5.6 Environmental Consequences of Alternative 3

5.5.6.1 Terrestrial Biota

Effects associated with Alternative 3 related to Village Creek WWTF expansion are similiar to those described for Alternative 1 (i.e., loss of some weedy field habitat), but to a lesser degree.

Construction of pipelines (196 ac for collection and 217 ac for conveyance to Mustang Creek) primarily along existing corridors would result in the temporary disturbance of approximately 413 ac of predominantly weedy field vegetation cover. Displacement of wildlife during this period should be minimal. Some disturbance during construction due to noise, dust, and human activity would occur to wildlife in adjacent habitats.

Following construction, biological communities would reestablish along all pipeline rights-of-way. Vegetation cover and wildlife would be displaced from a 40-ac stockpile site adjacent to the municipal landfill at the northern most site (Site 1). Some utilization by birds and perhaps other wildlife (as described for Alternatives 1 and 2) would occur at the Village Creek WWTF and and at the stockpile site.

In the 15,000-ac landspreading area, some toxic elements occurring in sludge as well as pesticides used to control weeds and insects potentially would adversely affect wildlife utilizing the area. Possible buildup of toxic chemicals (e.g., hydrocarbons and metals), especially in game birds, is of some concern.

At the Mustang Creek site (Site 3), 525 ac is designated for treatment and storage of wastewater. Vegetation (wildlife habitat) and wildlife utilizing this area would be displaced permanently. A storage reservoir would provide some aquatic habitat for aquatic oriented wildlife (predominantly waterfowl and other water birds). In addition to treatment and storage areas, 8,460 ac would be irrigated (sprayed) with sewage. Most of this land is presently in crop production (hay or grain fields). Since water would be available in larger quantities, most land presently not being used to grow hay is expected to be converted to hayfields (probably bermuda) and mowed periodically (5-6 times per growing season). The exact acreages of land conversion (grain to grass) is unknown, but a net reduction in grain or row crops is expected. This would result in a loss of unharvested grain as food especially for game birds (e.g., Bobwhite and Mourning Dove).

Uptake by plants and animals of toxic elements (e.g., metals and hydrocarbons) also would increase in irrigated lands. Major effects would be incurred by waterfowl using areas that drain irrigation land (such as wetlands, area ponds and Lake Benbrook). Domestic stock feeding on grass or fed hay also would be subject to increased uptake of toxic elements. Samples from soils, plants, and livestock would have to be tested frequently to insure levels of toxic elements remain within desirable limits.

5.5.6.2 Aquatic Biota

The West Fork of the Trinity River downstream from the Village Creek WWTF would receive increased sediments/turbidity during plant modification. Any effect to aquatic life is expected to be minimal. Upon completion of the WWTF modifications, improved water quality would result in a increased diversity of aquatic biota.

Streams and ponds draining the northern stockpile area (Site 1) would receive increased nutrients, metals, and other toxic elements. Eutrophication would increase in water bodies (especially ponds) receiving this drainage.

Erosion would cause sedimentation and turbidity and would result in a short-term decrease in aquatic productivity for some stream segments near pipeline construction areas, especially in new rights-of-way from the Crowley Pump Station to treatment and storage facilities. Quantities of sediment entering streams would depend primarily on the duration and magnitude of storm events occurring during construction. Severe erosion and sedimentation resulting in major impacts to aquatic biota are not expected.

5.6 CULTURAL RESOURCES

5.6.1 Existing Conditions

5.6.1.1 Laws and Regulations

Cultural resource investigations are required by law when a project involves a Federal action. Requirements are specified in the following Federal laws, regulations, and procedures:

- National Historic Preservation Act of 1966 (PL 89-665) (16 U.S.C. 470 et seq.);
- Executive Order 11593 (Protection and Enhancement of Cultural Environments);
- Archaeological and Historic Preservation Act of 1974 (PL 93-291) (16 U.S.C. 469 et seq.);

- 36 CRF 800--Protection of Historic and Cultural Properties;
- 36 CFR 60.6--National Register Criteria; and
- National Historic Preservation Act Amendment of 1980 (PL 96-515) (16 U.S.C. 470 note).
- National Environmental Policy Act of 1969 (PL 91-190)(42 U.S.C. 4321 et seq.);

Since the City of Fort Worth is a political body within the State of Texas, requirements of the Texas Antiquities Code would have to be met. Implementation of and compliance with the above Federal and state regulations and procedures prior to project completion would ensure adequate identification, evaluation, and mitigation of impacts on cultural resources in the project area.

These regulations and procedures stipulate that EPA, as the Federal financing agency, has the responsibility to ensure that all properties within project boundaries that are in, or eligible for inclusion in, the National Register of Historic Places are identified and evaluated and that potential effects on such properties are assessed. Compliance with these regulations and procedures requires a detailed inventory and assessment of the cultural resources that would be affected by the proposed project. Resources must be evaluated to determine their eligibility to the National Register of Historic Places. Resources are identified and inventoried through comprehensive surveys. The significance of a site and the potential loss that it represents is evaluated through testing programs subsequent to the survey. If a site deemed significant and eligible to the National Register may be impacted by the project, EPA must allow the Advisory Council on Historic Preservation an opportunity to comment before any action is taken. The regulations and procedures require consultation and coordination with the State Historic Preservation Officer (SHPO) during the cultural resource investigation. Final determination of the eligibility of a site for the National Register is made by the Department of the Interior in consultation with the State Historic Preservation Officer. EPA's responsibility can be fulfilled through promulgation of a Memorandum of Agreement (MOA) among the EPA, City of Fort Worth, State Historic Preservation Officer, Texas Department of Water Resources, and the Advisory Council on

Historic Preservation as specified in 36 CFR 800. If a project involves the USCOE (e.g., because of Section 10 and/or 404 permit requirements or involvement with USCOE-designated wetlands), then the SHPO also would request USCOE involvement in the MOA negotiations.

5.6.1.2 Known Cultural Resources of the Project Area

The cultural resources of Tarrant and Johnson counties are not particularly well known. The number of sites in each county on file with the Texas Archeological Research Laboratory (the state repository for site records), the number of State Historical Landmarks recorded with the Texas State Historical Commission and the appropriate County Historical Commission, and the number of sites included in or eligible to the National Register of Historic Places are presented in Table 5-16. Table 5-16 indicates that, comparatively, the cultural resources of Tarrant County are better known than Johnson County. Counts for each, however, do not represent the total number of sites that are probably present as neither county has been completely surveyed and inventoried. Any new land modification project that requires archaeological clearance potentially would result in identification of both new and previously recorded sites.

Prehistoric archaeology of the project region, along with the rest of north-central Texas, has been well summarized by Lynott (1977, 1981). However, no synopsis of historic archaeology is available, with the possible exception of investigations at the proposed Lakeview Reservoir (Skinner and Connors 1979). One problem with understanding cultural resources of Tarrant and Johnson counties and attempting to identify areas that may have a likelihood for sites is that very few systematic surveys involving large tracts of land have taken place in these counties. Such surveys result in identification of variation, density and distribution of historic and prehistoric sites within a confined area. Settlement data on location and distribution of sites from such surveys can then be used for assessing the likelihood of encountering sites in other adjacent areas.

With respect to prehistoric resources, larger and more densely occupied areas in the project region were along major drainages in the western and eastern

TABLE 5-16 HISTORIC AND PREHISTORIC SITES RECORDED IN TARRANT AND JOHNSON COUNTIES

	Tarrant	Johnson
Texas Archeological Research Laboratory (TARL)	67[a]	4
Texas Historical Commission (THC)/County Historical Commission	148	26
National Register of Historic Places (NRHP)[b]	31	3
Total	246	33

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a. Includes five sites recorded at Southern Methodist University but not yet cross-indexed with TARL.

b. Department of Interior, Heritage Conservation and Recreation Service 1979, 1980, 1981.

Cross Timbers biotic provinces, while occupations in the Grand Prairie and Blackland Prairie provinces appear to have been more marginal (Banks 1981). Preferred locations were sandy terraces overlooking floodplains, or rises within floodplains. Such sites have been identified in Tarrant County along the West Fork and the Clear Fork of the Trinity River, and along Village Creek and Rush Creek. Recent alluviation along many of the floodplains suggests the possibility of buried sites, and indeed such sites are known (Everett 1981).

Historic occupations in north-central Texas were not so closely affiliated with riverine and floodplain areas. The historic emphasis on cotton farming and cattle raising necessitated a more intensive utilization of upland environments. Coupled with this agricultural orientation have been the technological capabilities to secure water away from riverine areas, thus permitting historic populations to more intensively settle areas away from riverine environments. Initially, rivers such as the Trinity River were used as transportation routes (Richner and Bagot 1978), but with the advent of improved road systems and the railroad, this form of transportation was abandoned.

A variety of historic resources are present or potentially present in Tarrant and Johnson counties. They include: early trading posts and military forts, battle sites, farmsteads, early communities, cemeteries, churches, bridges and architecturally significant buildings. Because of the historic emphasis on agriculture, most historic resources are a direct result of or are closely affiliated with this economic base. The majority of historic resources consist of early farmsteads.

Evidence for human occupation in Tarrant and Johnson counties extends back at least 12,000 years, and four different occupation periods have been identified:

- Paleo-Indian (12,000-7,000 BP)[a];
- Archaic (7,000-1,500 BP);
- Neo-American or Ceramic (1,500-500 BP); and
- Historic (500 BP-Present).

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[a] BP = "Before Present," i.e., dating in radiocarbon years, measured back from 1950.

Each period is temporally distinct and identified by presence of certain diagnostic artifacts. Evidence for all periods have been found in either or both Tarrant and Johnson counties.

Paleo-Indian Period (12,000-7,000 BP). The Paleo-Indian Period represents the earliest, widely accepted evidence of human occupation in North America and is marked from that point in time when man migrated from the Old World to the New World during the latter stages of the Pleistocene. Paleo-Indian lifeways focused on exploitation of Late Pleistocene fauna by small, highly mobile groups. Many Paleo-Indian sites are surface finds, or are mixed in with artifact assemblages dating to later periods such as at the Coker-Bond site near Lake Worth (Preston 1976).

At present, no Paleo-Indian sites have been identified in Tarrant or Johnson counties. Sites possibly containing Paleo-Indian components have been located on Rush Creek (Whitsett 1976) and Big Bear Creek (Whitsett and Fox 1979). Surface finds of Paleo-Indian projectile points in Tarrant County have been located along a tributary of Silver Creek; the Trinity River floodplain east of Fort Worth; Village Creek near Kennedale; and north of Lake Worth. Presence of these artifacts suggests the possiblity of finding Paleo-Indian sites within the project region.

Archaic Period (7,000-1,500 BP). The Archaic period followed the Paleo-Indian and is identified by presence of large, stemmed dart points, gouges, grinding implements, and ground stone tools. The Archaic lifeway centered around seasonal movements by small groups that were exploiting a variety of locally available resources.

Archaic sites in the Trinity River basin often are found on the first (T1) terrace (Skinner, Richner and Johnson 1978). They are often buried and usually located only when tributaries, erosion or modern human activities have exposed sections of the terrace. Buried Archaic sites have been reported along the Trinity River in the Westover Hills area of Fort Worth (Everett 1981).

Archaic sites are probably the most numerous type of site in the study area. Archaic sites also have the greatest range in terms of size, artifact density, and type. This variability is a reflection of the broad range of resources exploited by Archaic groups.

A number of Archaic sites have been recorded in Tarrant and Johnson counties. Two of these are on the National Register of Historic Places: (1) the Ham Creek site in Johnson County; and (2) the Marrow Bone Spring site near Arlington in Tarrant County. Another well documented Archaic site in Tarrant County is the Coker-Bond site near Lake Worth (Preston 1976). Other Archaic sites in Tarrant County have been reported along the Trinity River, Rush Creek, Village Creek, Big Bear Creek, the east side of Eagle Mountain Lake, Lake Bridgeport, Lake Grapevine and Mountain Creek Lake (Whitsett 1976; Whitsett and Fox 1979; Skinner and Connors 1979; and Everett 1981).

Neo-American or Ceramic Period (1,500-500 BP). The Neo-American or Ceramic Period was the last phase of prehistoric occupation and culminated with the onset of Anglo-European exploration and settlement. Sites dating to this period are identified by presence of pottery along with small stemmed and tanged arrowheads. The Neo-American lifeway in the study area and most of the rest of north-central Texas essentially represents a continuation of the pattern established during the Archaic Period. Neo-American sites are comparatively rare within the study area, and most evidence for occupation of this period comes from sites that also have evidence of Archaic occupations. The presence of both Archaic and Neo-American artifacts within the same site attests to the similarities in lifeways. Other than a rare pottery sherd, there is no evidence in Tarrant or Johnson counties of the more sedentary, agriculturally-oriented Caddoan occupations of east Texas.

Generally, Neo-American Period sites consist of open camps on secondary terraces overlooking floodplains, floodplain knolls or rises or in upland areas between drainages (Banks 1979). Upland locations were used much more ephemerally than riverine and floodplain localities. Like Archaic sites, there is a likelihood for buried sites in floodplains.

Historic Period (500 BP-Present). The Historic Period began with the onset of early European exploration and settlement. In the study area, the Historic Period can probably be considered as beginning during the 1840's with the first real evidence of for Anglo settlement following the establishment of the Peters Colony in 1841. By 1848, the Texas Emigration and Land Company, which operated Peters Colony, had moved over 2,000 families into the 16,000 square miles of the colony, which encompassed parts of Tarrant and Johnson counties. The main thrust of settlement, though, came during the mid-to late-1800's. During this period cotton emerged as a dominant economic force, and the Trinity River became a major route for communications and the movement of goods. This period saw emergence of the City of Fort Worth, following establishment in 1849 of the military post for which the City is named. Other communities in the area included Birdsville which grew up around Bird's Fort, a fort established by Jonathon Bird in 1840 on the military road from the Red River to Austin.

Historic resources in the study area are extremely varied. Historic abroiginal sites have been identified (Preston 1977). Further, a Kichai Village was purported to have been situated on Village Creek in the mid-1800's, but this site has never been located. Its presence, however, was the cause of the Battle of Village Creek in 1841 (Whitsett 1976). The exact location of this battle also has never been determined, but the battle itself has been commemorated with a Texas State Historical Landmark.

Other historic resources include farmhouses such as those identified in the area of the Lakeview Project (Skinner and Connors 1979). Such farmhouses are probably the most frequently encountered resources outside the immediate area of the City of Fort Worth and the metroplex. In addition, the City of Fort Worth contains a variety of architecturally significant buildings, many of which have been commemorated with State Historic Landmark designation. A detailed idea of the range and variation of historic resources in the study area can be obtained by consulting the list of State Historic Landmarks for Tarrant and Johnson counties. This list is maintained by the Texas Historical Commission.

5.6.1.3 Environmental Sensitivity of Alternative Sites With Respect to Cultural Resources.

Detailed cultural resource investigations have been undertaken by TDWR staff. An on-foot survey of Site 2 was conducted by a TDWR staff archaeologist (see Appendix A). This survey covered the proposed landfill, the force main between the Village Creek WWTF and the landfill, and expansion of the Village Creek WWTF. Detailed pedestrian surveys of Sites 1 and 3 were not conducted by TDWR because specific locations for interceptor routes and landfill/land application sites were not designated in the City's draft facilities plan. The Village Creek, West Fork, Clear Fork and Walker Branch collectors were also surveyed.

Two days were spent by a qualified archaeologist conducting a drive-through, windshield reconnaissance of the Mustang Creek alternative area (Site 3), the Saginaw landfill/landspreading alternative area (Site 1), the proposed Village Creek force main route (between Sites 2 and 3), and the Village Creek WWTF site and adjacent landfill site (Site 2). The drive-through reconnaissance was undertaken to evaluate the landscape and environment in an attempt to assess the potential for encountering major cultural resources, given the existing data base for the study area.

Within the alternative project areas a survey of a proposed 22.5 mile sewage pipeline right-of-way along Rush Creek has been conducted (Whitsett 1976). Ten sites were recorded but only four (41TR6, 41TR7, 41TR11, and 41TR14) were considered as potentially eligible to the National Register of Historic Places and warranted further testing. Although a Rush Creek interceptor currently is being constructed, this testing was never undertaken. A review of Tarrant County archaeology, indicates a high probability of encountering prehistoric and historic resources in these areas. Prehistoric resources probably would be concentrated along streams, which most of the proposed gravity interceptors would follow, while historic resources would consist primarily of farmsteads and generally would be found in uplands where proposed land application and sludge landfill/landspreading alternatives would be located.

The Saginaw Alternative Area (Site 1). The Saginaw (Site 1) area is almost entirely in the Fort Worth (Grand) Prairie province, although the Western Cross Timbers province occurs at the extreme western edge, along Eagle Mountain Lake (Dyksterhuis 1947). This region largely consists of upland regions of pastureland. Several intermittent drainages cut through the region, including Henrietta Creek, Big Fossil Creek, Indian Creek and Big Bear Creek. These are all tributaries of the Trinity River.

Prehistoric sites have been recorded along the eastern edge of Eagle Mountain Lake (Everett 1981). These sites are outside and to the west of the sludge disposal target area (Site 1). In general, prehistoric sites in the Saginaw area (Site 1) would probably be similar to those in the Mustang Creek area (Site 3), and would be most prevalent along creeks.

Historic farmsteads also were noted in this area. If the selected siting involves one of these buildings, the same procedures as outlined for the Mustang Creek area would be followed. Like the Mustang Creek area, this alternative probably has more potential for impacting historic sites than prehistoric sites.

The Village Creek WWTF (Site 2). The existing WWTF site was examined. Construction of the facility has disturbed much of the surface of the floodplain. It is believed that the facility was constructed on a prehistoric site (Helm 1981). Because extensive surface disturbance has occurred, it is unlikely that any significant cultural resources remain at that location.

Trinity River Landfill (Site 2). The archaeological staff of the TDWR recently completed a cultural resource survey of the areas which would be affected by the City's preferred alternative (TDWR 1983). No artifacts or archaeological features were found in this area.

Mustang Creek Alternative Area (Site 3). The location of this alternative site is situated on the watershed divide between the Trinity and the Brazos river basins. Mustang Creek and the Nolan River have their headwaters at this site. Mustang Creek flows northeasterly into the Trinity River while the Nolan River flows south into the Brazos River. The area is predominantly within the Fort Worth Prairie, or Grand Prairie province (Dyksterhuis 1946) and consists of gently rolling plains that are presently in pasture. Soils observed in cutbanks are fairly shallow (i.e., approximately 50 cm) and are quite rocky.

Since prehistoric occupations in this region of Texas were oriented towards riverine environments, particularly along major streams, this area appears to have little potential for large, intensively occupied sites. The area consists predominantly of uplands, thus any prehistoric sites would probably consist of small scatters of lithics that have low artifact densities and very shallow cultural deposits, if present at all. Such sites would most probably occur along Mustang Creek and the Nolan River as opposed to upland areas away from the creeks.

Historic farm buildings were observed in the area, and these would have to be assessed as to their potential for inclusion in the National Register of Historic Places. They also should be assessed as to their potential for inclusion in the Historic Architectural Building Survey (HABS) and the National Architectural and Engineering Record (NAER). In all probability, this alternative has more potential for impacting historic resources than prehistoric resources.

Mustang Creek Force Main Route. The pipeline route (i.e., route for a force main from the Village Creek WWTF to Site 3) was evaluated by following roadways that parallel Village Creek. The creek is within the Eastern Cross Timbers province (Dyksterhuis 1948) and is one of the major tributaries of the West Fork of the Trinity. Prehistoric sites previously have been identified along Village Creek, and many appear to have loci of major occupations. The floodplain probably has the potential for buried sites, since such sites have been located along the West Fork of the Trinity. Prehistoric sites along Village Creek are most likely to occur on terraces and floodplain rises. This force main route likely would have a greater impact on prehistoric sites than historic sites.

Gravity Interceptors. The rights-of-way for the proposed Village Creek, West Fork, Clear Fork, and Walker Branch gravity interceptors have been investigated. Three sites were located during the survey. One site is a scatter of historic artifacts on the route of the Village Creek collector. Two prehistoric sites were identified along the route of the Clear Fork collector. These sites should be avoided during construction of the collectors. If the collectors must cross these sites, construction should be confined to existing disturbed areas. If it is not possible to avoid these sites, it is recommended that they be tested to determine their eligibility for nomination to the National Register of Historic Places. It is anticipated no further surveys of rights-of-way would be required (TDWR 1983).

It is noted that several sections of the Rush Creek interceptor that previously were examined were recommended for testing; however, testing was not conducted. Since the Rush Creek interceptor currently is being constructed under a separate contract and is not a part of this facilities planning effort, testing of Rush Creek sites would not be conducted for or as part of this project.

5.6.2 Environmental Consequences of the No Action Alternative

If no action is taken, abnormal impacts to cultural resources would not occur. Cultural resources in the study area would be subject to natural processes of destruction, i.e, erosion and deterioration, as well as possible destruction from other forms of development. Unidentified cultural resources in the study area would not be inventoried.

5.6.3 Environmental Consequences of Alternative 1

Since sludge would be transported by truck to the landspreading site along pre-existing roads, this method of transportation would have no significant impact on cultural resources. The sludge stockpile site north of Saginaw would have to be surveyed and assessed once the exact site was selected. Similarly, modifications at the WWTF should be monitored during ground disturbing activities for the possibility of buried cultural material (Whitsett 1982). Conduct of these activities in accordance with current regulations would result in no adverse impact on cultural resources.

Three potentially significant cultural resource sites have been identified along pipeline routes. These sites may be eligible for nomination to the National Register of Historic Places. It appears that the routings of the Village Creek and Clear Fork collectors can be designed to avoid these sites. This would result in no effect on cultural resources. If these sites cannot be avoided, additional work may be necessary to determine the eligibility of the sites for the National Register and the extent of the potential effect of the construction of the lines on the resource.

5.6.4 Environmental Consequences of Alternative 2A

Use of a pre-existing or newly developed municipal refuse landfill would not require archaeological clearance as part of this project. The sludge stockpile site would have to be surveyed, as explained for Alternative 1. Modifications at the Village Creek WWTF would be monitored during ground disturbing activities. Conduct of these activities in accordance with current regulations would result in no adverse effect on cultural resources. Impacts of collection line construction would be similar to those discussed for Alternative 1.

5.6.5 Environmental Consequences of Alternative 2B

With this alternative, sludge would be moved by pipeline from the Village Creek WWTF to a landfill site north of and adjacent to the Trinity River. Planning and design will allow avoiding the known sites within the right-of-way of the pipeline. If these sites are avoided, this alternative would have no effect on cultural resources. Modifications at the Village Creek WWTF also would be monitored during ground disturbing activities. Impacts of collection line construction would be similar to those discussed for Alternative 1.

5.6.6 Environmental Consequences of Alternative 3

All rights-of-way, pumping station sites, sludge storage ponds, and those areas to be irrigated with sewage effluent and/or liquid sludge would require archaeological clearance. This is required because application of sewage phosphates and modern carbon could chemically contaminate archaeological sites. Modern carbon would render useless any material that could potentially be radiocarbon dated. Modifications at the Village Creek WWTF also would be monitored during ground disturbing activities. Conduct of these activities in accordance with current regulations would result in no adverse effect on cultural resources. Impacts of collection line construction would be similar to those discussed for Alternative 1.

Implementation of the preferred alternative of the City of Fort Worth would have no effect on cultural resources provided the three sites identified along collector routings are avoided. The Texas Historical Commission has cleared the project provided the significant sites are avoided (see Appendix A).

The TDWR archaeologists identified a slight potential for the city of Fort Worth encountering significant cultural resources in construction of any wastewater treatment facilities. If any cultural resources are discovered during construction, the City would be required to halt work and contact EPA, the TDWR and the Texas Historical Commission so that the significance of the resource could be determined. Appropriate consultation with the State Historic Preservation Officer and the Advisory Council on Historic Preservation would be undertaken in order to comply with Section 106 of the National Historic Preservation Act, as amended. If the final alternative selected by the City of Fort Worth is not the one currently identified by the City as its preferred alternative, additional cultural resources surveys may be required.

5.7 POPULATION

5.7.1 Existing Conditions

5.7.1.1 General Population Trends in Tarrant County

The service area lies entirely within the Dallas/Fort Worth Standard Metropolitan Statistical Area (SMSA). Past and current population trends of the study area are strongly influenced by larger metropolitan areas in Tarrant County. Results from the 1970 US Census Bureau reports show that the population of Tarrant County increased by 32.8 percent from 1960 to 1970 (538,495 to 715,587).

The 1980 census indicates that population growth in Tarrant County slowed from 1970 to 1980; total population increased by 18.1 percent from 715,587 to 845,418. Annual growth from 1970 to 1980 was 1.7 percent per year. This figure is approximately 1 percent below the annual growth rate from 1960 to 1970 of 2.9 percent per year. Population in Johnson County during the period 1970 to 1980 increased by 45.4 percent from 45,679 to 66,453. Average number of persons per household in 1980 was estimated by the Census Bureau to be 2.72 for Tarrant County and 2.88 for Johnson County.

Incorporated areas in the Fort Worth service area with the largest increases in population between 1970 and 1980 were Arlington and North Richland Hills. In Arlington, the population increased by 77.5 percent from 90,229 to 160,123. In North Richland Hills, the population increased by 85.2 percent from 16,514 to 30,592. Other portions of the Village Creek WWTF Service area had significant increases in population during the same period. These areas include Saginaw (140.8 percent), Edgecliff Village (135.8 percent), and Crowley (119.8 percent).

Not all parts of the Fort Worth service area experienced growth during the 1970's. The following areas declined in population from 1970 to 1980: Westworth Village (20.2 percent), River Oaks (15.9 percent), Kennedale (15.7 percent), Lake Worth Village (11.4 percent), Richland Hills (10.0 percent), and Fort Worth (2.1 percent). Table 4-2 (see Chapter 4) listed service area population projections through 2005 for sewersheds in the Fort Worth service area. These projections reflect past demographic trends indicating an overall increase in population for the service area with some areas showing rapid growth and other areas slow growth.

5.7.1.2 Population Trends at Alternative Sites

Population in communities near all three sites increased at a much higher rate than the state and the study area as a whole. The community of Saginaw near Site 1 grew by 140.8 percent from 1970 to 1980. During the same period, the City of Arlington, immediately south of Site 2 increased in population by 77.5 percent. Near Site 3, the community of Crowley grew in size by 119.8 percent in the same decade. Growth in communities in Johnson County near Site 3 was not as great as those in Tarrant County, but still was significant. The communities of Burleson and Godley grew by 44.0 and 15.2 percent , respectively, during the period from 1970 to 1980.

5.7.2 Environmental Consequences of the No Action Alternative

Under the no action alternative, demographic and economic growth may be limited by inadequate wastewater collection and treatment capability. Collection lines already are overloaded at some points in the system. The Rush Creek, Village Creek, Walker Branch and 72-in collection lines comprised of M-245 and M1-I1 currently are overloaded. Growth would be limited in these sewersheds as well as the overall service area if treatment capacity were not increased.

Inadequacy of the existing wastewater treatment facilities would possibly cause industries to relocate outside of Tarrant County, which would subsequently cause population to stabilize or decrease. In addition, lack of adequate treatment capabilities may cause limitations to be placed on residential construction. An imposition such as this would cause population growth to be reduced or halted and result in adverse affects on the economy.

5.7.3 Environmental Consequences of Alternative 1

Landspreading of sludge may inhibit residential growth adjacent to Site 1. No significant movement of population out of the Site 1 area is anticipated as a result of implementation of this alternative.

5.7.4 Environmental Consequences of Alternative 2A

Consequences of Alternative 2A for population are similar to those for Alternative 1. Alternative 2A involves a much smaller land area than Alternative 1, therefore inhibiting effects on possible residential growth are decreased.

5.7.5 Environmental Consequences of Alternative 2B

Alternative 2B is not projected to cause significant population growth at Site 2. The area adjacent to Site 2 is not appropriate for residential development since it is within the Trinity River floodway. Development of the landfill and use of Site 2 for demonstration of beneficial reuse would not affect development or population growth in the area.

5.7.6 Environmental Consequences of Alternative 3

Implementation of Alternative 3 would have the same effects as those associated with Alternative 1. There also may be restriction of residential growth in areas around Site 3, the slow rate irrigation area in Johnson County. Construction of the pipeline may contribute to population growth (low to moderate) in the vicinity of Crowley and Kennedale.

5.8 LAND USE

5.8.1 Existing Conditions

5.8.1.1 Study Area

During the past several decades the predominent land use in the project area has been agricultural, primarily cropland (Figure 5-16). Johnson County presently consists of approximately 60 percent cropland, 30 percent rangeland, with the reaminder divided almost evenly among water, forest land and urban or built up land. Tarrant County (due to Fort Worth) is approximately 30 percent urban, 50 percent cropland, 10 percent rangland 5 percent water and 5 percent forest land. As urbanization in areas in the Fort Worth area the urban percent in Tarrant County would increase significantly.

Both land treatment areas (i.e., Sites 1 and 3) are lands where the predominate existing land use is cropland. Expansion of facilities at or near the present Village Creek WWTF would occur in predominately rangeland and forest land uses.

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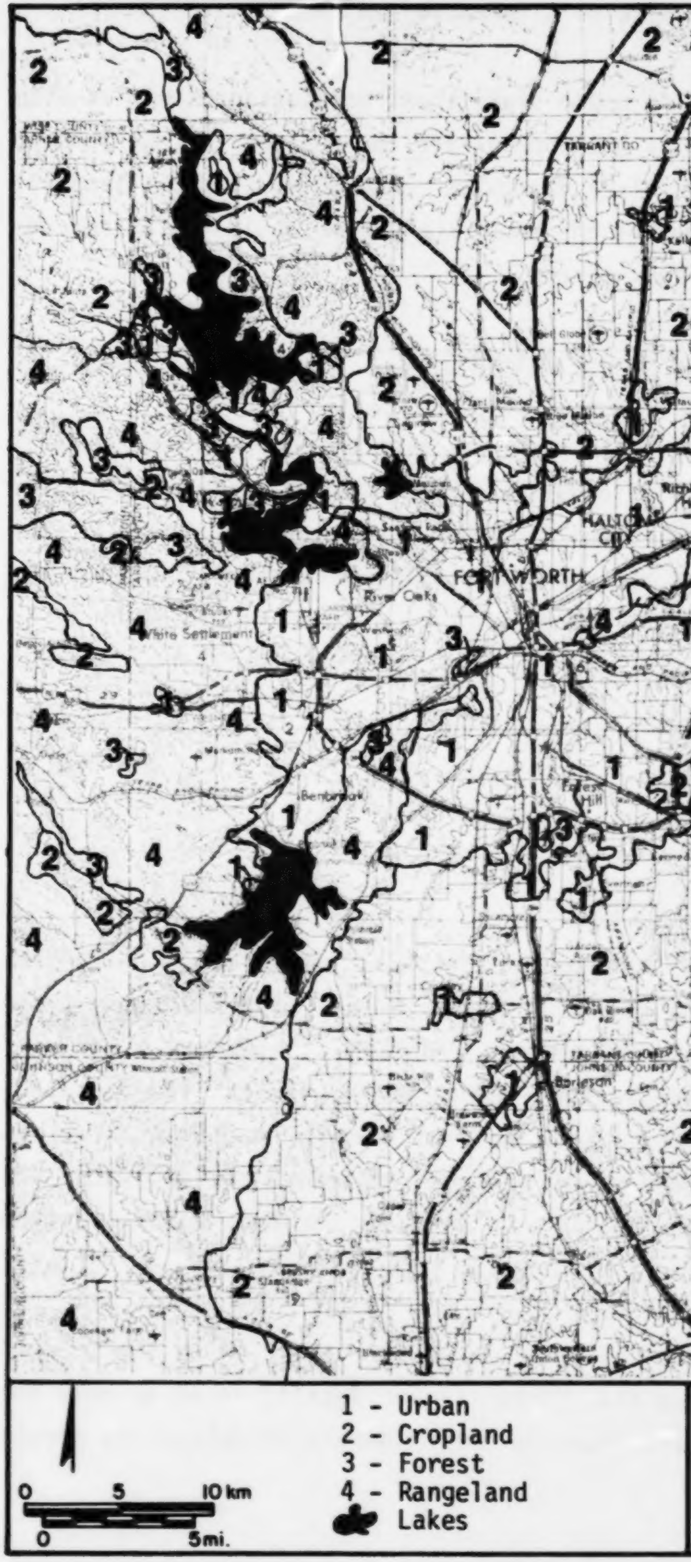

FIGURE 5-16. EXISTING LAND USE IN THE FACILITIES PLANNING AREA (SOURCE: TDWR 1978).

5.8.1.1 Village Creek WWTF Area (Site 2)

The Village Creek WWTF is located in Fort Worth in an area zoned for single family residences. However, government facilities which are owned and operated by or under control of the City of Fort Worth, or under other government authority also are included in this zoning. The location of the proposed landfill on Site 2 occurs in the Trinity River floodplain and is zoned industrial. The Tarrant Sanitation Company sanitary landfill is operating adjacent to the proposed landfill, and several other landfills occur farther east and west of the proposed landfill. Major future changes in land uses are not anticipated.

The Prestonwood residential area of Arlington is located to the south and east of Site 2. Prestonwood is zoned residential by the City of Arlington and is planned for single family detached residences, although government facilities also are permitted. Land directly east of Site 2 (approximately 840 ft wide) is zoned for industrial development. However, it is unlikely that this area would be developed in the near future. No future land use changes are anticipated (Sims 1982).

5.8.1.2 Sludge Application/Landfill Area (Site 1)

The general area targeted for landspreading of sludge or landfilling of sludge is largely a rural/agricultural area with scattered population centers. Eagle Mountain National Guard Base is located in the western part of the target area and is used fulltime as a training area. Saginaw, Blue Mound, and Lake Highland Estates are among the larger communities surrounding Site 1. In the future, as these communities and the City of Fort Worth expand, agricultural land would be converted to residential use. For the 20-year life of this project, it is probable that the rural/agricultural environment will still be predominant, although land closest to Fort Worth may more become urban (i.e., residential, business, and industrial).

5.8.1.4 Mustang Creek Area (Site 3)

Land use of the Mustang Creek area is predominantly cropland and rangeland. A majority of the population is clustered around the communities of Godley and Cresson, although farms are scattered throughout the area. Landowners who own part of the land on which the storage reservoir would be constructed, as well as land to the north and east of the proposed reservoir, plan to sell their land in small tracts for residential development. Currently a small percentage of the land has been sold, and mobile homes are located on a few of these tracts.

The long-term trend in the area is for urbanization of the agricultural land, especially in areas near Fort Worth and Godley (Ballard 1982). As with other agricultural land uses in Texas, there is a gradual shift from cropland to pastureland.

5.8.2 Environmental Consequences of the No Action Alternative

If the Fort Worth System is not expanded, effects observable at the three proposed sites would include (1) possible lowering of the value of land in adjacent residential areas at the Village Creek WWTF (Site 2), thus restricting development; (2) no change in the projected land use of Site 1; (3) no change in the projected land use at Site 3.

5.8.3 Environmental Consequences of Alternative 1

Expansion of the Village Creek WWTF from 96 mgd to 137 mgd would occur on land within the existing wastewater facility complex, and therefore would not constitute a change in land use. Expansion should not directly affect the land use of the surrounding area (residential). It is expected that emission of odors would decrease due to discontinued use of the drying beds and the employment of better odor control techniques at the plant (see Section 5.4.3.1). Regardless of the treatment/disposal techniques used, there would still be some odor generated from the facility; however, the odor should be less than what is currently being emitted.

The short-term increase in construction noise levels would not significantly affect the surrounding land use due to the distance from the construction site to the residential areas. Minor increases in operational noise likewise are not expected to affect residential land uses located near the plant.

In the predominantly rural/agricultural setting of Site 1, application of soil conditioners and soil fertilizers (including animal manure) to agricultural land is a common part of the land use. Therefore, application of sludge as a soil conditioner to land currently used for crop production would be compatible with the current use. Sludge would be applied at the farmer's discretion only to lands being used for agricultural purposes.

Application of sludge to cropland would not change the land use of areas surrounding farms. Sludge would undergo digestion, drying, and some uncontrolled composting prior to landspreading. The sludge would have a musty odor similar to the smell of humus. Generation of uncharacteristic odors significantly different from what currently exist is not expected.

It is unlikely that Site 1 would be completely urbanized in the 20-year life of this project (Moncivais 1982). A more probable scenario would involve conversion of some agricultural land in the southern section of this area to urban use. In light of this scenario, a probable effect would be that land previously available for agricultural purposes now would not be available, due to urbanizing. This gradual conversion would not significantly reduce the farmland available for sludge application.

5.8.4 Environmental Consequences of Alternative 2A

Effects on land use resulting from expansion of the Village Creek WWTF would be the same as those presented in Section 5.8.3.

Construction and operation of a sludge stockpile adjacent to a municipal landfill at Site 2 would affect only a small portion of the surrounding land use. At this time, the Fort Worth Department of Public Works, Sanitation Division has not determined the exact location of the landfill. Compatibility with surrounding land use would be one of the major criterion used in siting the landfill. The landfill would exist regardless of whether or not it is used for sludge disposal. Land use effects due only to disposal of sludge in the landfill would be negligible.

5.8.5 Environmental Consequences of Alternative 2B

The effects on land use resulting from expansion of the Village Creek WWTF would be the same as those presented in Section 5.8.3.

Construction and operation of a landfill in the Trinity River floodplain south of the WWTF would result in conversion of up to 500 acres of naturally occurring floodplain to a developed land use. This change in land use is not unusual, since several existing landfills occur in the Trinity River floodplain to the east and to the west of the proposed landfill. Future development of the land where the landfill is proposed is not planned.

5.8.6 Environmental Consequences of Alternative 3

Since the Village Creek WWTF would not be expanded beyond its current capacity in this alternative, the surrounding land use would not change. A beneficial effect would result from a reduction in the generation of odors due to the discontinued use of the existing sludge drying beds. More efficient odor control techniques are proposed to be utilized at the existing Village Creek WWTF.

Irrigating crops with wastewater effluent at Site 3 should enhance the agricultural use of the site; no uncharacteristic odors are expected. Construction of the aeration lagoon, storage reservoir, and buffer zone would convert approximately 600 acres of grazingland to a developed land use. Odors emitted from these facilities could negatively affect any developable use of the land, especially to the north and east where residential development is proposed. Since the prevailing winds blow from the south-southeast, depending on the exact location of future developments it is probable that they would be affected adversely by odor.

Possible mitigative measures such as a vegatation buffer zone and/or relocating the storage reservoir and lagoon should be considered to reduce or eliminate negative effects to present land uses of this area.

The proposed wastewater force main would follow existing pipeline and highway rights-of-way from the Village Creek WWTF to the storage reservoir at Site 3. Construction of a new pipeline would not significantly affect land use along the route of the existing pipeline. There is a potential for induced growth along the new force main between the Crowley Pump Station and Site 3. Effects of this induced growth could be mitigated by requiring that requests to tie into this section of pipe receive prior approval from the City of Crowley, the Fort Worth Planning Department, and/or the North Central Texas Council of Governments.

5.9 TRANSPORTATION AND COMMUNITY SERVICES

5.9.1 Existing Transporation Systems

In general, transportation systems serving Fort Worth and Tarrant County are typical of those serving most major urban centers. Paved roadways range from 2-lane residential streets capable of carrying approximately 1,000 vehicles per hour (vph) to 6 and 8-lane interstate highways with capacities exceeding 10,000 vph. Major interstate highways aligned north-south, east-west, and looping Fort Worth provide rapid access to all points in the Dallas-Fort Worth Metroplex and Tarrant County. Rail service is provided on major rail lines such as the Texas and Pacific, Atchison Topeka and Santa Fe, Fort Worth and Denver, and others. Commercial and private air travel is served at D/FW regional airport, Meacham Field, and numerous other private fields. Carswell Air Force Base also operates in west Fort Worth. There are no substantial river travel (e.g., barge) facilities currently available.

Impacts of various alternatives on transportation are very site specific; therefore, transportation facilities at each alternative site are briefly discussed below.

5.9.1.1 Landfilling/Landspreading Area (Site 1)

Major roads through the sludge landfill/landspreading area include Loop 496, US 81-287, IH 35W, Farm to Market (FM) 156, Peden Road, Blue Mound Road and Keller-Haslet Road. The Chicago, Rock Island and Pacific Railroad; Fort Worth and Denver Railroad; Atchison, Topeka and Santa Fe Railroad; and the Missouri Pacific Railroad cross through the landfill/landspread target area. Vehicles used for landspreading would not be routinely used on public roads. Airports in this immediate area (5-mile radius) include four public airports (Saginaw, Blue Mound, Meacham and Alta Vista), and two private airstrips (Oliver and Bell Globe) along with Carswell Air Force Base approximately 6 mi southwest of the area.

5.9.1.2 Village Creek Area (Site 2)

The Village Creek WWTF is accessed through Wilma Lane and Bedford Road. Other major roads in the area include Davis Drive, Fielder Road, and residential streets throughout the Prestonwood neighborhood. Although a future major east-west highway is proposed for construction in the vicinity of the WWTF, the proposed highway would not provide a more direct route to the Saginaw target sludge application area. There are no railroads or airports in the immediate area; however, Bell Helicopter does utilize several heliports located approximately 5 mi north of the Village Creek WWTF.

5.9.1.3 Mustang Creek Area (Site 3)

Major roads through the Mustang Creek land treatment site include FM 2435 and FM 917. The Atchison Topeka and Santa Fe Railroad crosses through the land treatment site. There also are five private airports in the Mustang Creek area--Standridge, Hawkins, Thomas, Bransom Farm, and Briar Hill.

5.9.2 Environmental Consequences of the No Action Alternative on Transportation

If none of the alternatives are implemented, existing transportation would be affected very little. Undigested or poorly digested sludge would be stockpiled initally at the existing drying beds and around the Village Creek WWTF, prior to disposal at one or several landfills. Trucks hauling sludge to various landspreading areas would not significantly affect local traffic. Sludge would be disposed of at one of the Fort Worth landfills, or at a private landfill. It is uncertain currently, which landfill would be used; therefore, the route that haul trucks would follow cannot be determined. However, trucks transporting sewage sludge would comprise a small percentage of the trucks going to the landfill; therefore, the primary effect would be the reduced life of the roads due to additional weight of the sludge bearing trucks.

The transportation system would continue to follow existing transportation plans. The Arlington Traffic and Transportation Department plans to extend Green Oaks Boulevard to form a loop around Arlington. The extension would be located just south of the sludge drying beds, and motorists would be affected by odor caused by inadequately digested sludge being placed on drying beds.

5.9.3 Environmental Consequences of Alternative 1 on Transportation

Transportation impacts in the vicinity of the Village Creek WWTF are expected to be minimal. During construction, the effects on roadways in the vicinity of the Village Creek WWTF would be minor since most heavy construction equipment would remain on-site. Sludge generated by the Village Creek WWTF would be trucked north via the following route: plant road to Bedford Road, thence to Anderson Road, thence to Raider Drive, thence to SH 183, thence to IH 820, thence to IH 35W, thence to US 81 to a 175-acre stockpile area assumed to be adjacent to a municipal landfill.

Bedford Road is a two-lane road built by Tarrant County. The original bridge over the West Fork Trinity River was closed due to structural problems, and Bedford Road has been detoured to a one-lane pre-existing bridge. This road is used for transportation to and from work by employees at industries in the area such as Bell Helicopter. Four or five trucks (30 cubic yard capacity each) would make approximately five trips each day (20-25 truck trips) to carry sludge to the stockpile area. Traffic approaching the one-lane bridge would be affected, especially during peak traffic hours. The City would make every effort to avoid using the bridge during peak traffic hours, thereby ameliorating traffic congestion at the bridge. Other roads along the truck route are Anderson Road (two-lane), Raider Drive (two-lane), State Highway 183 (four-lane), Interstate 820 (four-lane), Interstate 35W (four-lane), and US 81-287 (four-lane). On the four-lane highways, the sludge trucks should cause no traffic probelm due to the small number of trucks relative to the total number of vehicles on the roads and the road capacities. Truck traffic on two-lane roads would tend to reduce traffic speed and cause periodic congestion.

The sludge stockpile would be located adjacent to a municipal landfill site. The Fort Worth Department of Public Works, Sanitation Division has not determined the exact location of the municipal landfill, therefore impacts to the roads in the immediate vicinity cannot be assessed. However, it is known that trucks transporting sewage sludge would comprise a small percentage of the trucks going to the landfill area. Sludge trucks would weigh more than other trucks going to the landfill area; therefore the major effect would be a reduced life of the roads and accelerated deterioration of the surface.

No railroads or airports in the area would be adversely affected by Alternative 1. Application of sludge on the land would produce a temporary increase in the population of insects within the area which potentially would attract additional birds to the area for a short period of time (2-3 days). A temporary increase in the number of birds would increase the probability of bird strike damage to small planes operating at low altitudes adjacent to the landspreading target zone. Airports in the vicinity of Site 1 include four public airports (Saginaw, Blue Mound, Meacham and Alta Vista), and two private airstrips (Oliver and Bell Globe) along with Carswell Air Force Base approximately 6 mi southwest of the site. The increase in and significance of the bird strike hazard to small aircraft cannot be statistically determined at this time.

5.9.4 Environmental Consequences of Alternative 2A on Transportation

Impacts to the transportation system around the Village Creek WWTF would be minimal during construction, as most of the heavy construction vehicles would be operating on-site. The route that the approximately 25 trucks transporting sludge would follow would be the same as discussed in Section 5.9.3; therefore, the impacts would be the same. The Fort Worth Department of Public Works, Sanitation Division has not decided on the exact location of the municipal landfill. It should be noted that the 25 sludge trucks represent a very small percentage of the total number of trucks transporting material to the landfill. However, since the average weight of the sludge trucks (37 tons) would be heavier than the average weight of the City garbage trucks (19 tons), maintenance requirements for the roads used by the sludge trucks likely would increase.

No railroads or airports in the area would be adversely affected by Alternative 2A.

5.9.5 Environmental Consequences of Alternative 2B on Transportation

Effects to roadways in the vicinity of the Village Creek WWTF would be minor during construction, since most heavy construction vehicles would remain onsite during construction. Since sludge would be pumped to the 500-ac landfill site across the Trinity River and not hauled by truck, effects to transportation would be negligible. No effects are anticipated to rail or air traffic since there are no railroads or commercial airports close to the Village Creek WWTF.

5.9.6 Environmental Consequences of Alternative 3 on Transportation

Trucks transporting sludge from the Village Creek WWTF to the stockpile site would have a similar effect as that described in Section 5.9.3. However, there would be fewer trucks with Alternative 3 since the plant capacity would be 96 mgd instead of 137 mgd.

Construction of the wastewater-conveyance pipeline would cause a temporary disruption of traffic on roads which intersect the pipeline route. This short-term disruption is not expected to significantly affect transportation patterns or usage in the project area. Pipeline crossings at major roads would be by boring, versus the open trench-cut method, which should reduce traffic disruptions considerably. Railroad crossings also would be constructed using the boring method.

No railroads or airports in the area would be adversely affected by Alternative 3. There are five private airports in the Mustang Creek site -- Standridge, Hawkins, Thomas, Bransom Farm, and Briar Hill. The bird strike hazard would be smiliar to the effect described in Section 5.9.3.

5.9.7 Existing Community Services

A facility such as the proposed Village Creek WWTF can have a significant and potentially adverse effects on community services in the facilities planning area if the project is not integrated into the regional planning process. Community services could be indirectly affected by a proposed project if secondary (or induced) growth occurs that is substantially different than that planned for by regional planning agencies. However, for the Fort Worth system, secondary growth different than that projected by the NCTCOG is not anticipated; therefore, all impacts on community services should be minor. The increase of population supported by any of the action alternatives would potentially place additional demands on police and fire protection, education and health facilities, in addition to community utility services (power, water, telephone, sewage and refuse collection). However, these demands are expected and currently are being planned for. Current community services are adequate for existing population and can support some population growth. Table 5-17 presents data on educational, public safety and health care services in Fort Worth and Tarrant County. The community services are above recommended levels for existing population.

TABLE 5-17 COMMUNITY SERVICES - FORT WORTH AND TARRANT COUNTY

	FORT WORTH	TARRANT COUNTY
PUBLIC SCHOOLS		
Gross Average Daily Attendance (ADA)	60,164	149,321
Full Time Employees	3,334	8,422
Full Time Employees Per 1,000 ADA	0.55	0.66
PUBLIC SAFETY		
Total Police	682	1,236
Total Firemen	604	956*
Police per 1,000 Population	1.77	1.46
Firemen per 1,000 Population	1.58	1.13
HEALTH CARE		
Operational Hospital Beds	NA	4,167
Average Daily Census	NA	3,002

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* Does not include all volunteer firemen

NA - Not Available

SOURCE: TEXAS DEPARTMENT OF HEALTH 1980.

5.9.8 Environmental Consequences of the No Action Alternative on Community Services

Adequate wastewater treatment facilities are a critical element in the continued growth and development of a community. Expansion of all community services is necessary to accommodate growth. Fort Worth is in a region which has both a growing economy and population. The inability of any community service to meet increased demands may inhibit development. Given that some population growth through natural increase and in-migration is anticipated for both Fort Worth and Tarrant County, expansion of community services is necessary to maintain current levels of service and safety in the area. Wastewater treatment is a crucial element, in that public health can be detrimentally affected by an inadequate system. If the no action alternative is implemented, future growth and development in Fort Worth and Tarrant County may be inhibited. Public health also may be adversely affected by implementation of the no action alternative.

5.9.9 Environmental Consequences of Alternatives 1, 2A, 2B and 3 on Community Services

Impacts to community services from the four proposed action alternatives would be similar and would occur primarily within the area in which the selected alternative is located. A long-term increase in population would occur due to the increased sewage capacity available for future development. The short-term effects would be minimal. The majority of the labor force required to construct the proposed facilities would come from the labor force currently residing within the region. Net migration of labor force into the area would be minimal.

Availability of new sewage lines and treatment capacity would increase the potential for future development. Future development primarily would occur in the areas served by the additional sewer capacity provided, as projected by NCTCOG. Since the Fort Worth area, in general, is increasing in population it is likely this growth would continue, especially in undeveloped areas with reserve sewage capacity. The long-term increase in population would place additional demands to extend or increase basic public services presently offered.

Short-term disruptions of utility services (water, gas, power, telephone) could occur due to accidental severing of unmarked utility lines or when the exact locations of utility lines are unknown. These disruptions, causing interruptions in services to some local residents and businesses would be infrequent and of a short duration.

5.10 SOCIOECONOMIC RESOURCES

5.10.1 Existing Conditions

6.10.1.1 General Economic Activities and Trends

The Dallas/Fort Worth SMSA area economy has displayed stable, rapid growth, becoming a major regional trade and financial center. The metroplex economy is addressed herein by providing information on employment for the entire SMSA. Specific information for Tarrant County and/or the City of Fort Worth is provided where possible. Both Dallas and Fort Worth have a great deal of economic autonomy, thus separate treatment of the Fort Worth area is provided since it is the major city in the study area.

Economic activity in an area frequently is measured in terms of goods and services produced locally which supply a demand generated outside the region. These activities are defined as basic activities. The Dallas/Fort Worth SMSA area economy has a well diversified economic base characterized by many industrial sectors that can be defined as basic. Basic industries in 1980 included manufacturing; transportation; utilities and communications; trade; service; and finance, insurance, and real estate.

Presence of these basic industries in 1980 has not changed from the industrial base evidenced in 1976, indicating stable economic growth. There is a shift away from total dependence upon basic (export) economic activity as the area is increasingly able to generate new economic activity on its own. This type of regional economy is considered self-sustaining.

Construction activity is an indicator of general economic growth resulting from both increased population and capital investment by business and government. New starts in both single and multifamily dwellings increased from 1975 to 1978 and then declined significantly between 1979 and 1980 (this is consistent with national trends). However, commercial and industrial construction remained active and allowed industry to show an overall increase in the period 1979 to 1980 (USDOC 1981).

Currently, Tarrant County has a growth rate of 2.1% per year. The 1980 US Census (USDOC 1981) reveals that the population of Tarrant County was 860,880. Incorporated areas with the largest percent increases in population between 1970 and 1980 are Burleson (224.6%), Crowley (119.8%), Edgecliff Village (135.8%), Saginaw (140.8%), Bedford (107.2%), Colleyville (100.5%), Keller (181.1%), Wautauga (172.2%), and Westlake (328.6%).

Incomes in the study area (Tarrant County) are relatively high when compared to the US average. In 1981, the per capita income in Tarrant County was $11,219 compared to $12,144 for Dallas - Fort Worth SMSA and $10,945 for the United States (USDOC 1983). In general, increases in average earnings were greater for durable goods than nondurable goods.

5.10.1.2 City Finances

The annual budget for fiscal year 1980-1981 (FY 80/81) for the City of Fort Worth represents a 9.9% increase over the previous budget. The budget is based upon a ten cent ad valorem tax rate reduction which has resulted in a decrease in the level of several municipal services.

Sources of revenue are anticipated to undergo severe strain: citizen concern over ad valorem taxes may preclude any significant increases from this source and fiscal restraint at the Federal level is anticipated to result in cutbacks in several local grant programs. According to the City Manager, Robert L. Herchert, this could "have serious consequences for the City", and any reductions in consumer spending will result in lower revenues from sales taxes (Herchert 1980).

The City proposes to increase use of service or user fees as a means to regulate demand for these services, as well as to partially cover the cost of rendering such services.

Revenues for the General Fund of the City of Fort Worth come from a variety of sources. Approximately 62% of all revenues are derived from some type of tax; however, ad valorem property taxes account for 60% of all local taxes. User charges for current services provided the next largest source of revenue for the City. Water and sewer services are rendered by the City, but are not funded from the General Fund.

5.10.1.3 Water and Sewer Operating Fund

The budget of the Water and Sewer Fund is separate from that of the General Fund. The total water and sewer fund proposed budget for FY 80/81 is $36,437,931, an increase of $4,382,299 (or 13.67%) from FY 79/80. This budget provides for a $2,254,978 increase for operation and maintenance of the Village Creek WWTF. Income from water and sewer services and contracts provided more than 95% of total revenues. Approximately 15% of total revenue was derived from water and sewer contracts. Wastewater treatment accounted for 42% of the sewer operating fund, which was 19% of the combined water and sewer fund. Combined debt service represented 18.48% of the total fund, with debt service for the sewer fund accounting for 56% of the total debt service requirement for FY 80/81. Residential customers account for over 40% of total sewer revenue. Among 22 neighboring cities, the average monthly bill ranged from a low of $1.34 in Hurst to a high of $3.54 in Crowley for FY 78/79 (City of Fort Worth Water Department, 1980).

5.10.2 Environmental Consequences of the No Action Alternative

5.10.2.1 General Economic Activities and Trends

Primary effects of the no action alternative on economic resources would be indirect, resulting from restrictions on growth of the project area. Overloaded wastewater collection systems would make extensive new development unfeasible, resulting in an effective ceiling on population growth in the Fort Worth service area. Restriction of growth potentially would lead to a downturn in local economic conditions.

Failure to expand wastewater collection and treatment facilities would result in more frequent episodes of system upset or failure. This situation would result in increased odor and insect problems, causing deterioration of residential and aesthetic values of existing neighborhoods near the plant. Under these conditions, property values in residential areas near the plant might decline, and could cause severe economic impacts on real estate values in that area.

5.10.2.2 City Finances

The no action alternative could lead to limitations in economic and population growth resulting in a limited tax base with which to fund City services. The existing tax base would have to provide all revenues for future City Services which are dependent on funding derived from taxes. The No Action Alternative would have no effect on the City of Fort Worth's debt service requirements.

Frequency of system upset may increase under the No Action Alternative the City of Fort Worth might be liable for payment of fines of up to $10,000 per day under Federal statutes.

5.10.2.3 Water and Sewer Operating Fund

Implementation of the no action alternative would have no impact on the water and sewer operating fund of the City of Fort Worth.

5.10.3 Environmental Consequences of Alternative 1

5.10.3.1 General Economic Activities and Trends

Implementation of Alternative 1 would enhance population and economic growth in the Fort Worth service area by increasing collection and treatment capability. Land values at the Saginaw area (Site 1) could be negatively affected, particularly for residential development due to aesthetic and odor considerations. However, values of cropland and pastureland where sludge is disposed could be enhanced. Residents near the Village Creek WWTF (Site 2) contend that insect and odor problems have led to a decline in property values in the vicinity of the Village Creek WWTF. There currently is no data available to support or refute this contention. If property values have been affected, reduction of insect and odor problems through improvement and/or expansion of the Village Creek WWTF may stabilize residential property values in the area.

Total average cost per connection per month is projected to range between $11.49 and $16.25, depending on the amount of Federal funding (if any) made available to the City. Based upon EPA guidelines (see Section 4.9), these monthly costs would not represent an economic burden on low income families in the service area.

5.10.3.2 City Finances

Fort Worth would finance its share of the project through wastewater revenue bonds. Alternative 1 would be implemented in a shared manner in order to avoid undue burden on the City of Fort Worth's debt service.

5.10.3.2 Water and Sewer Operating Fund

Construction of new facilities would require increased expenditures for operating and maintenance costs. The higher expenditures would be covered by increased revenues through a greater number of connections in the service area and through increased monthly user fees.

5.10.4 Environmental Consequences of Alternative 2A

5.10.4.1 General Economic Activities and Trends

Effects of this alternative would be similar to those for Alternative 1. Some differences in economic impact would occur at the landfill site. Alternative 2A would involve less acreage at Site 1; therefore, its potential effect on land values would be less. Alternative 2A calls for concurrent use of a planned solid waste landfill. Alternative 2A would add no additional impacts beyond those already caused the by municipal refuse landfill. Alternative 2A may, as in the case of Alternative 1, have a stabilizing effect on land values of residential properties close to the Village Creek WWTF.

Total average cost per connection per month is projected to range between $11.20 and $16.03, depending on the amount of Federal funding (if any) made available to the City. Based upon EPA guidelines (see Section 4.9), these monthly costs would not represent an economic burden on low income families in the service area.

5.10.4.2 City Finances

Impacts of Alternative 2A would be the same as those described for Alternative 1.

5.10.4.3 Water and Sewer Operating Fund

Impacts of Alternative 2A would be the same as those described for Alternative 1.

5.10.5 Environmental Consequences of Alternative 2B

5.10.5.1 General Economic Activity and Trends

Effects of this alternative would be similar to those of Alternative 1, with some differences occurring due to use of different sites. Impacts on land values at Site 2, north of the Village Creek WWTF, are expected to be negligible due to current land use in that area. As with other alternatives, expansion of the Village Creek WWTF potentially may have a stabilizing effect on local residential property values.

Total average cost per connection per month is projected to range between $10.46 and $15.32, depending on the amount of Federal funding (if any) made available to the City. Based upon EPA guidelines (see Section 4.9), these monthly costs would not represent an economic burden on low income families in the service area.

5.10.5.2 City Finances

Impacts of Alternative 2B would be the same as those described for Alternative 1.

5.10.5.3 Water and Sewer Operating Fund

Impacts of Alternative 2B would be the same as those described for Alternative 1.

5.10.6 Environmental Consequences of Alternative 3

5.10.6.1 General Economic Activities and Trends

Effects of Alternative 3 would be similar to those of other alternatives. Property values near the Village Creek WWTF potentially would be stabilized by improvements made at the Village Creek WWTF. Additional impacts on land values at the Mustang Creek area (Site 3) also would be beneficial. Property values immediately adjacent to the aerated lagoons and storage reservoir potentially might decline due to the effects of odor and noise. Farm operators using wastewater for irrigation potentially would receive increased revenues from higher crop yields.

Total average cost per connection per month is projected to range between $10.91 and $18.75, depending on the amount of Federal funding (if any) made available to the City. Based upon EPA guidelines (see Section 4.9), these monthly costs would not represent an economic burden on low income families in the service area.

5.10.6.2 City Finances

Impacts of Alternative 3 would be the same as those described for Alternative 1.

5.10.6.3 Water and Sewer Operating Fund

Impacts of Alternative 3 would be the same as those described for Alternative 1.

5.11 ENERGY RESOURCES

5.11.1 Existing Conditions

Energy demands of the existing Village Creek WWTF are primarily related to operation of the treatment plant and fuel use for vehicles (i.e., fuel utilization) associated with the plant's operations.

5.11.1.1 Treatment Plant

The existing Village Creek WWTF uses energy primarily in the form of electricity, natural gas, methane, and propane. Texas Electric Service Company (TESCO) supplies electricity within the project area. The company's total net generating capacity is about 6,000,000 kilowatts (kw). The transmission system is interconnected with those of Dallas Power and Light Company, Texas Power and Light Company, and Houston Lighting and Power Company. Natural gas is supplied by Lone Star Gas Company and is used at Village Creek WWTF as a supplemental fuel to run multi-fuel gas engines whose cooling water is used to heat the anaerobic digesters. The digesters in turn produce methane gas which is utilized in operation of grease incinerators, multi-fuel gas engines that drive electric power generators and blowers, and for mixing contents of the anaerobic digesters. The existing energy system has a number of operational problems that currently are being corrected. If the existing energy recovery system works effectively, energy utilization and energy savings would be as presented in Table 5-18. The Village Creek WWTF consumes about 3,400 kwh per million gallons of wastewater treated, which is within the range of reasonable consumption for similar plants.

TABLE 5-18. EXISTING ENERGY UTILIZATION AT THE VILLAGE CREEK WWTF.

Parameter	Units	ADF	MDF
Energy Production			
a. Sludge Flow	(tpd)	114	140
b. Gas Production	(scfd)	1.28×10^{6}	1.42×10^{6}
c. Energy Production	(btuh)	32×10^{6}	35.4×10^{6}
Energy Use for Blower/Generators			
a. Energy Available For Power (32%)	(btuh)	10.24×10^{6}	11.33×10^{6}
b. Utilization for Blowers/ Generators			
(i) Total Connected Power	(bhp)	8520	8520
(ii) Firm Usable Power (50%)	(bhp)	4260	4260
(iii) Maximum Energy Utilization	(btuh)	10.85×10^{6}	10.85×10^{6}
(iv) Additional Energy Required	(%)	6	0
Energy Use For Building Heat			
a. Energy Available (20%)	(btuh)	6.4×10^{6}	7.08×10^{5}
b. Energy Utilized	(btuh)	0	0
Energy Available			
a. Total Available per Year	(kwh/yr)	69×10^{6}	
b. For Engine Operation	(kwh/yr)	22.1×10^{6}	
c. For Sludge Digetion Heating	(kwh/yr)	22.8×10^{6}	
d. For Space Heating	(kwh/yr)	13.8×10^{6}	

SOURCE: CDM et al. 1983.

5.11.1.2 Vehicles

Presently, gasoline and diesel are the major vehicle fuels that are being utilized during plant operations. Fuel is used by vehicles for minor plant activities such as removing and stockpiling sludge on the drying beds.

5.11.2 Environmental Consequences of the No Action Alternative

If no action is taken, energy requirements of the Village Creek WWTF would increase proportionate to the flow increase from 85 mgd (current flow) to 137 mgd. Methane production would only increase slightly because sludge would not remain in the anerobic digesters for the specified length of time. The slight increase in the quantity of sludge produced would require a nominal increase in the amount of diesel fuel required for transporting the sludge to the ultimate disposal site. Undigested, stockpiled sludge would be unacceptable for use as a soil conditioner, thus all sludge would probably be trucked to a landfill. Vehicle fuel use would increase significantly if the no action alternative was selected.

5.11.3 Environmental Consequences of Alternative 1

As a result of expanding the plant from 96 mgd to 137 mgd, additional gas would be produced, additional sludge heating would be required for digestion, additional power would be generated, and additional heat would be available for space heating. Energy requirements of the expanded plant as well as the energy saved by recovering methane gas are as follows (CDM et al. 1983):

Total energy required	149.6×10^6 kwh/yr
Energy recovered	67.7×10^6 kwh/yr
Net energy required	81.9×10^6 kwh/yr

Increase in energy consumption and fuel would occur during the period of construction. The additional energy required can be supplied by Texas Electric Service Company, Lone Star Gas Company, and other suppliers.

Diesel fuel would be used to fuel the twenty-five truck loads of sludge per day being transported to the stockpile . Diesel fuel supplies in Fort Worth are adequate to meet this demand.

5.11.4 Environmental Consequences of Alternative 2A

Energy requirements for the expanded facility would be the same as those presented in Section 5.11.3. Diesel fuel requirements also would be the same as described in Section 5.11.3 for Alternative 1.

5.11.5 Environmental Consequences of Alternative 2B

The additional sewage capacity for Alternative 2B would be the same as Alternative 2A (137 mgd). Use of additional liquid fuels would be minimal. Sludge would be pumped through a dual pipeline to the sludge dewatering area. The amount of power consumed would be greater than that for other alternatives. Addition of dewatering equipment and pumps would use the majority of additional power. After dewatering, sludge would be placed in the proposed landfill or be available for beneficial reuse.

5.11.6 Environmental Consequences of Alternative 3

Energy required by the Village Creek WWTF and by the land treatment (slow rate irrigation) facilities as well as energy saved by recovering methane gas from the anerobic digesters would be as follows:

Total energy required	176.5×10^6 kwh/yr
Energy recovered	58.4×10^6 kwh/yr
Net energy required	118.1×10^6 kwh/yr

The additional energy requirements associated with Alternative 3 can be supplied by Texas Electric Service Company, Lone Star Gas Company and other suppliers. Diesel fuel would be required by construction equipment and can be easily obtained from local suppliers. The net production of sludge from this alternative would decrease, thus the methane gas available for collection and utilization would be less than with alternatives 1, 2A, and 2B. Net energy required to be purchased is greater with this alternative than for alternatives 1, 2A, and 2B.

5.12 ENVIRONMENTAL HEALTH

5.12.1 Existing Conditions

The existing wastewater management system serving the Fort Worth/Arlington area is adequate for the amount of sewage generated by the current population and there are no documented environmental health problems. Currently, there are no major epidemic-type health problems in the project area (Hull 1982).

There is a problem with flys in the Prestonwood neighborhood in Arlington due to the sludge drying beds. The flys became a serious problem starting in 1981 and since that time the Arlington Environmental Health Department has received several hundred complaints. The fly problem is most severe in the Prestonwood neighborhood to the south and east of the drying beds during the period from mid-April to mid-May, due to the prevalence of north-northwesterly winds during that time period. The Cities of Fort Worth and Arlington have worked with Dr. John Owens, an entomologist with Texas A&M University, to help solve the fly problem. Fort Worth sprays insecticide around the drying beds with limited success. In 1981, Arlington sprayed insecticide in the Prestonwood neighborhood in an effort to reduce the fly problem, but discontinued the practice on the advice of Dr. Owens due to lack of effectivness. After mid-May, the wind direction shifts away from the north-northwest; therefore, the flies are not a serious problem after mid-May in the Prestonwood area (Hull 1982).

Domestic sewage can be a source of pathogenic bacteria, viruses, parasites, and fungi that may initiate infections in susceptible host upon exposure. Such exposure may occur through direct sewage contact; contact with contaminated material; or inhalation, ingestion, or contact with pathogenic aerosols.

Human diseases which could be associated with improperly handled sewage are briefly discussed below.

Diseases Caused By Bacteria. There are several bacterial diseases associated with sewage wastes which are commonly found in the US. Tuberculosis and typhoid fever are two well-known diseases which have been associated with sewage-associated pathogens (Cornell University 1976).

Diseases Caused By Virus. Viruses associated with the human digestive system are of particular interest to waste management workers. Methods of virus transmission are uncertain in some cases. However, fecal samples often contain virus particles and it is assumed that viruses can be passed from sewage wastes into other persons. Infectious hepatitis is a viral disease which has been shown to be transmitted through the fecal contamination of drinking water or food.

Diseases Caused By Protozoans. Ameobic dysentery is the only protozoan disease of general interest to waste management workers in the United States. It is caused by the protozoan known as *Entamoeba histolytica*.

Diseases Caused By Helminths. Tapeworms, roundworms, and flukes are helminths which parasitize humans and which are associated with improperly handled sewage wastes (Cornell University 1976).

5.12.2 Environmental Consequences of the No Action Alternative

A decision not to expand the wastewater treatment system potentially would have an adverse effect on environmental health. A wastewater treatment system that is properly operated and not overloaded would remove moderate to significant amounts of bacteria, viruses, protozoans and helminths. Treatment of the remaining sludge removes additional amounts of pathogenic organisms through anaerobic digestion. In the no action scenario, wastewater and sludge would not receive thorough treatment when the plant is overloaded, therefore there would be a reduction in the percentage of pathogens killed. Quality of the wastewater effluent being released to the Trinity River would deteriorate. Improperly treated sludge placed on the existing drying beds would cause a significant odor problem to the Prestonwood area as well as a potential problem with pathogenic aerosols and disease transmission by carriers such as flies.

5.12.3 Environmental Consequences of Alternative 1

5.12.3.1 Sludge Disposal Site (Site 1)

Digested and dried sewage sludge would be disposed by application to agricultural land. The obvious advantage of the application of sludges to agricultural lands is the inherent recycling of nutrients that were derived from soil by plants and utilized at various points in the human food chain. In agrarian societies, the majority of constituents found in waste being returned to agricultural lands came originally from these lands in the form of plant matter. In modern industrial societies, this simplistic system is significantly complicated by the addition of materials to wastewater streams that originate from sources other than the food supply. In particular, these materials include trace element contaminants, synthetic/organic chemicals, and biocidal materials. These additional materials along with pathogenic microorganisms pose potential adverse health consequences to mankind when wastewaters and sludges are applied to agricultural lands. The application rate, the quantity of pollutants in the sludge, and cation exchange capacity of the soil are important in determining the potential for groundwater contamination; and in addition, the pH of the soil is important in determining plant uptake of pollutants. For Alternative 1, the sludge application rate would be low (2.6 tons per acre per year), the concentration of those pollutants which were analyzed is not above average, and the cation exchange capacity of the soil is high, therefore the potential for groundwater contamination is low. The alkaline nature of the soils should reduce the concentration of pollutants in plants grown on soil conditioned with sludge.

There generally is a possibility of human disease being caused by pathogenic organisms in sludge applied to land. Soil is generally a hostile environment for pathogens, however, there is evidence of survival of pathogens for varying lengths of time. The USEPA promulgated regulations (40 CFR Part 257) to control land application of sewage sludge for protection of human health. The farmers who use the sewage sludge would be required to follow the requirements specified in 40 CFR Part 257, therefore there should not be a public health problem associated with the land application of sewage sludge. Criteria for application of sludge to land for production of food-chain crops are contained in 40 CFR Part 257.

5.12.3.2 Village Creek Site (Site 2)

Some of the microorganisms present in wastewater and sludge, especially bacteria and viruses, can become airborne as aerosols. Major sources of aerosols at the Village Creek WWTF are the aeration basins (activated sludge units). Inhalation is a possible route of infection because viruses and most pathogenic bacteria are in the respirable size range (Majeti 1981). Pathogens (including viruses and bacteria) present in wastewater are reduced through the treatment process. Pathogens that do become airborne are reduced by factors such as relative humidity, temperature, sunlight, and biological decay.

Current research indicates that working at or living near a wastewater treatment plant does not present a hazard to people due to pathogenic aerosols (Pahren 1981). Several reasons have been suggested to explain the lack of correlation between pathogenic aerosols and human disease:

(1) Densities of specific pathogens in aerosols are low, and are reduced rapidly with time and distance from the source.

(2) With a respiration rate of approximately one cubic meter per hour, a person would ordinarily inhale very few organisms unless constantly exposed for many hours.

(3) Exposure levels are below the minimum infective dose.

(4) Microorganisms in wastewater primarily affect intestines, whereas the route of exposure is respiratory. Proper surface receptor sites for organisms may not have been available.

(5) Nonspecific immunity, which responds quickly to foreign substances, was capable of handling the few microorganisms inhaled.

(6) Exposed persons are probably in good health and better able to combat infection than would sickly persons.

(7) Infectious agents other than those checked may have caused an undetected infection (Pahren & Jakubowski 1981).

Significant odor problems can cause negative health effects, including headache and nausea (National Research Council 1979). Alternative 1 is expected to reduce odor generated from the WWTF. Drying beds would be abandoned (except for emergency use) and odor at the WWTF would be treated by chemical addition or other means; thus substantial adverse effects due to pathogenic aerosols and odors should not result due to implementation of Alternative 1.

5.12.4 Impacts Resulting From Alternative 2A

5.12.4.1 Sludge Disposal Site (Site 1)

Sludge would be disposed of in a municipal landfill. The landfill primarily would be used for disposal of municipal solid waste and would be constructed in accordance with Texas Department of Health regulations promulgated to protect public health. Sludge initially would comprise approximately 10 percent of the material to be disposed of in the landfill; therefore, public health effects attributable to sludge disposal are expected to be minimal. In the future, the sludge will comprise 20 to 30 percent of the material placed in the landfill. Adverse effects also would not be anticipated in the future since dried sludge often is suitable for use as cover material at landfills (TDH 1974).

5.12.4.2 Village Creek Site (Site 2)

Environmental health effects of expanding the Village Creek WWTF from 96 mgd to 137 mgd would be the same as presented in Section 5.12.3.2.

5.12.5 Environmental Consequences of Alternative 2B

Impacts on public health from expansion of the treatment plant would be the same as Alternative 1. Impacts on public health from the landfill disposal method would be similar to Alternative 2A. The fly problem would be greatly reduced and possibly eliminated since sludge would not be placed or stored in the existing drying bed area except in emergencies.

5.12.6 Environmental Consequences of Alternative 3

5.12.6.1 Village Creek Site (Site 2)

Odor from the Village Creek WWTF would decrease due to abandoning the sludge drying beds, except in emergencies, and improved odor control. The plant would not be expanded and there should be no additional environmental health problems.

5.12.6.2 Mustang Creek Site (Site 3)

Wastewater effluent applied by sprinklers would produce a mist, often referred to as drift, that can be transported by wind currents. Mist droplets that are extremely small in both dimension and mass are referred to as aerosols. Aerosols generated by wastewater that has not been disinfected contain active bacteria and viruses, therefore the possibility exists for infection of the general population and workers. However, as was discussed in Section 5.12.3.1, no correlation has been found between working at or living near a wastewater treatment plant and human disease. Several possible reasons for this lack of correlation were presented in Section 5.12.3. To reduce aerosol production, sprinklers on this system would spray downward with a low nozzle pressure. Also, the closest population center is approximately one mile from an irrigation rig, thereby allowing drift to disperse before reaching a concentration of people. However, isolated individuals could be affected.

Groundwater contamination and associated public health problems are a potential problem with land treatment of wastewater effluent (see Section 5.2). The combination of soils in the Mustang Creek area, depth to groundwater, and quality of effluent indicate that groundwater contamination would not be a problem with this system. The concentration of specific ions in the effluent is well within recommended limits established by EPA. Inorganic chemical constituents, such as trace metals, usually are removed from percolating water by adsorption or chemical precipitation within the first few feet of soil. Solids contained in wastewater effluents would be filtered from the water in the upper layer of soil. Bacterial removal from effluent passing through fine soil, such as the Mustang Creek soil, is quite complete. The nitrogen loading compared to nitrogen uptake of the expected crops indicates that significant amounts of nitrogen would not enter the groundwater. Therefore, it is not expected that groundwater contamination would present an environmental health problem.

Propagation of mosquitoes and flies, which can accompany a land treatment system, can pose a health hazard as well as a nuisance condition. Increases in mosquito populations is mainly attributable to the wetter environment and the availability of standing puddles for breeding; however, the potential increase with this system is no greater than that expected with irrigation systems not using wastewater effluent. This system would be designed to reduce the amount of standing water; however, minor increases in mosquito and fly populations in areas currently not irrigated would occur.

5.13 RECREATIONAL AND AESTHETIC RESOURCES

5.13.1 Existing Conditions

Because of interest shown by the public in the unacceptable aesthetic conditions of the Village Creek WWTF, aesthetic resources have become a key issue in the planning process. The Village Creek WWTF is visible from some Arlington residences located on surrounding hills. Sludge drying beds are particularly unattractive to the public. In addition to visual aesthetic considerations, odor has been an acute source of discontent among area residents.

Recreational resources in the study area include the Trinity River and its tributaries. The City of Fort Worth has prepared numerous planning reports recommending extensive development of the recreational potential of the Trinity River and the tributaries and creeks draining into it. Many streams are presently neglected as recreational resources because of poor water quality or low flow conditions. The segment of the Trinity River beginning at the Navarro County-Henderson County line and continuing into Tarrant County as far as the Beach Street Bridge is water quality limited and is approved only for irrigation and industrial use by the Texas Department of Water Resources. The West Fork Trinity River segment also is water quality limited as far as the Lake Worth Dam, but it is approved for contact recreation, noncontact recreation, propagation of fish and wildlife, and domestic water supply. The rest of the area's streams are suitable for contact recreation.

The western edge of the Site 1 area targeted for sludge application or landfill borders on Eagle Mountain Lake. This lake is used extensively for recreational purposes such as boating and fishing. The Texas Parks and Wildlife

Department is planning to establish a 400 to 700 ac park on the eastern side of the lake approximately midway between the northern and southern ends of the lake (Whaylen 1982). The existence of a state park should serve to intensify recreational uses of Eagle Mountain Lake.

Water from Mustang Creek drains into Lake Benbrook. Lake Benbrook and the surrounding area currently is used for a wide variety of recreation including fishing, boating, skiing, bird watching, hiking, camping, picnicking, horseback riding, tennis, basketball, baseball, and golf. In addition, a beach facility with lifeguards and water slides is currently being constructed. The future use of Lake Benbrook is expected to be the same, but with more intensive use.

An operating sanitary landfill is adjacent to Site 2 north of the Village Creek WWTF. An abandoned sand and gravel quarry that has not been reclaimed is also present on-site. The recreational and aesthetic value of Site 2 is relatively low.

5.13.2 Environmental Consequences of the No Action Alternative

If no action is taken, recreation of the area should remain relatively the same and would continue to follow the long-range trends that were presented in Section 5.13.1. Contact and non-contact recreation on the Trinity below where the WWTF effluent enters would be limited due to a deteriation of water quality caused by overloading the plant. Aesthetics of the area surrounding the WWTF would deteriorate due to odor from the plant and the drying beds.

5.13.3 Environmental Consequences of Alternative 1

5.13.3.1 Land Application Area (Site 1)

Sludge would be applied to land currently used for agricultural production and would not interfere with recreational use of this land. Water quality degradation of Eagle Mountain Lake would not be expected (see Section 5.3.3), therefore recreation on the lake would not be affected. Application of sludge to agricultural land is not out of the ordinary for the area and would not affect the aesthetics of the targeted area.

5.13.3.2 Village Creek Area (Site 2)

Expansion of the Village Creek WWTF from 96 mgd to 137 mgd would not negatively affect the recreation and aesthetics of the area. Aesthetics of the area should improve from the visual as well as odor perspective due to abandoning the sludge drying beds, except for emergency purposes.

5.13.4 Environmental Consequences of Alternative 2A

5.13.4.1 Landfill Area (Site 1)

An area for the municipal landfill has not yet been chosen by the Fort Worth Department of Public Works, Sanitation Division. It is expected that the area they choose would not be used intensively for recreational purposes and would be removed from population centers that would be affected by aesthetic deterioration of the area. Sludge would comprise a small percentage of the material to be disposed of in the municipal landfill. It should be noted that the landfill would be constructed, regardless of whether or not it is used for sludge disposal; therefore, impacts on aesthetics due only to sludge disposal would be minimal and would only relate to the added capacity necessary to handle the sludge.

5.13.4.2 Village Creek Area (Site 2)

Effects to the recreation and aesthetics of the Village Creek area would be as presented in Section 5.13.3.

5.13.5 Environmental Consequences of Alternative 2B

5.13.5.1 Landfill Area (Site 1)

Given that the aesthetic and recreational value of the landfill site is low due to previous and current land use activities, construction of the landfill should have minimal impact. Use of the area for demonstration of beneficial re-use of sludge may have both adverse and beneficial impacts. Sludge stockpile and composting operations could be unsightly if not well planned and operated. Proposed beneficial reuse deomonstration programs include strip mine reclamation and park development. Development of these programs would lead to improved recreational potential and aesthetic value of the landfill area.

5.13.5.2 Village Creek Area (Site 2)

Effects to the recreation and aesthetics of the Village Creek area would be as presented in Section 5.13.3.

5.13.6 Environmental Consequences of Alternative 3

5.13.6.1 Village Creek Area (Site 2)

There would be no adverse effect on the recreational use of the Village Creek area from implementation of Alternative 3. Aesthetics of the area should improve from the visual and odor perspective due to abandoning the drying beds, except for emergency purposes.

The pipeline route to the Mustang Creek irrigation site would cross park and open areas on the west side of Lake Arlington. There would be some aesthetic alteration as well as loss of recreational use of some areas during construction. Since the pipeline would be constructed in existing rights-of-way, no long-term changes in recreation or aesthetic values are expected.

5.13.6.2 Mustang Creek Area (Site 3)

Crop irrigation with municipal wastewater would not affect recreation or aesthetics of the area. No water quality degradation of Lake Benbrook would be expected; therefore, the recreational use of the lake would not be affected.

The aerated lagoon and storage reservoir would not affect recreational use of the area. Odor generated from these facilities would have a negative aesthetic affect. A more detailed discussion of the odor impacts is presented in Section 5.4. Creation of the storage reservoir and lagoon also would alter visual aesthetics of the area.

In general, impacts from Alternative 3 on recreational and aesthetic resources would be minimal or temporary. During construction of the pipeline and wastewater application facilities, there would be some loss of aesthetic values. However, these effects should be temporary or restricted to areas of relatively low population density. There would be no major impacts on recreation areas or facilities in the area.

5.14 MITIGATION OF ADVERSE EFFECTS AND UNAVOIDABLE IMPACTS AND RESOURCE COMMITMENTS

The following sections discuss principal mitigation measures which can potentially reduce or elimate impacts that could occur from implementation of any of the four final alternatives discussed in Chapters 4 and 5. Most of the mitigation measures listed below have been or are presently being considered for implementation by the grant applicant (City of Fort Worth). Unavoidable impacts and resource commitments also are described.

5.14.1 Minimization of Construction Impacts

Construction activities could cause adverse impacts associated primarily with construction of new pipelines, expansion of the Village Creek WWTF, and construction of new facilities in virgin areas. Adverse impacts due to construction can be controlled, and most should be of short duration.

Fugitive dust generated by construction activities at construction sites can be reduced by use of several techniques. Construction sites, spoil piles, and unpaved access roads can be wetted periodically to minimize dust. Spoil piles also can be covered with matting, mulch, and other materials to reduce susceptibility to wind erosion. Street sweeping at access sites would control loose dirt that could be "tracked" onto roadways by construction equipment.

Trucks that haul spoil from excavation and trenching sites should have covers to eliminate escape of dust while in transit to disposal sites.

Proper maintenance of construction equipment would minimize emmissions of hydrocarbons and other fumes. Air pollution control devices also could be used on stationary internal combustion engines.

Major noise impacts occur during construction phases. The degree of effect would depend heavily upon population density and proximity of human habitation to the noise sources. Impacts of noise from construction activities and equipment can be mitigated by proper maintenance of equipment and installation of noise attenuating devices. Dozers, backhoes, and cranes are major noise sources, and modern exhaust muffling equipment could significantly reduce levels of noise from these sources.

Where land would be disturbed and soils exposed, measures should be taken to minimize erosion. In Program Requirements Memorandum 78-1, EPA established requirements for the control of erosion and runoff from construction activities. Adherence to these requirements would minimize the potential for problems. The requirements include:

- The project plan and layout should be designed to fit the local topography and soil conditions;

- When appropriate, land grading and excavating should be kept at a minimum to reduce the possibility of creating runoff and erosion problems that would require application of extensive control measures;

- Whenever possible, topsoil should be removed and stockpiled before grading begins;

- Soil exposure should be minimized in terms of area and time;

- Exposed areas subject to erosion should be covered as quickly as possible by means of mulching or vegetation;

- Natural vegetation should be retained whenever feasible;

- Appropriate structural or agricultural practices to control runoff and sedimentation should be provided during and after construction;

- A stabilized drainage system (temporary and permanent systems) should be completed as early as possible to reduce potential for erosion;

- Access roadways should be paved or otherwise stabilized as soon as feasible; and

- Clearing and grading should not be started until a firm construction schedule is known and can be coordinated effectively with grading and clearing activities.

Disturbance of terrestrial flora and fauna in areas of construction could be mitigated through careful choice of access roads to construction sites, muffling engine noise, and use of the narrowest practical right-of-way along pipeline routes. Short-term adverse impacts on aquatic biota would occur as a result of erosion and siltation at construction sites. These impacts can be mitigated by employing construction methodologies for erosion and sedimentation control and quick revegetation of denuded areas.

Federal regulations and procedures require that care be taken early in the planning process to identify cultural resources which may be affected. Upon formulation of final design plans and specifications with identification of interceptor routes and exact landfill or land application sites, a cultural resource management program can be developed. In order to comply with Section 106 of National Historical Preservation Act, as amended, EPA would carry out the required consultation with the Texas State Historic Preservation Officer and the Advisory Council on Historic Preservation. The goal of the consultation would be to identify and minimize impacts on cultural resources.

Appropriate planning could control construction-related disruption in the community. Announcements should be published in newspapers and broadcast through other news media to alert drivers of temporary closings of primary traffic routes during construction of sewer collection lines or force mains. Traffic control may be needed at points where certain construction equipment would enter public streets from access areas. Special care should be taken to minimize disruption of access to commercial establishments and to frequently visited areas. Planning of routes for heavy construction equipment should include consideration of surface load restrictions to prevent damage to streets and roadways.

5.14.2 Minimization of Operational Impacts

Impacts related to operation of the Village Creek wastewater facilities would be minimal if the facilities are designed, operated, and maintained properly. Proper and regular maintenance of collection and treatment components would be essential to maximize efficiency and to prevent adverse impacts. Aerosols, gaseous emissions, and noise from various treatment processes would be controlled to a large extent. Concentrations of effluent constituents discharged from the WWTF would be regulated by conditions of the proposed NPDES permit. The permit would specify the discharge quality and would require regular monitoring of the effluent. Periodic plant inspections would be conducted by TDWR and EPA . If conditions of the permit are violated, enforcement actions could be taken against the City of Fort Worth to insure compliance.

Degradation of water quality due to discharge of contaminated runoff from treatment facilities would be minimal. Major treatment works (i.e., Village Creek WWTF and landfills) would be enclosed with dikes which would contain runoff. Major sludge storage areas would be paved with runoff directed to evaporation ponds. Proper installation and operation of dikes or pond systems to control other minor sources of runoff would reduce the potential for these impacts.

Odors would continue to be periodically generated by both wastewater treatment and sludge disposal facilities. Odors from the Village Creek WWTF would be controlled to a great extent by chemical addition practices. If odor control by chemical addition is unsatisfactory, state of the art air collection and scrubbing facilities could be installed at key odor producing locations.

Other operational impacts such as occasional noise, traffic disruption and creation of unsightly or aesthetically displeasing areas also can be avoided to a great extent through adequate planning of events and proper operation and maintenance of facilities.

5.14.3 Unavoidable Adverse Impacts

Some impacts associated with implementation of any of the four recommended alternatives cannot be avoided. These include the following short-term and/or long-term effects:

- Construction activities would create fugitive dust, noise and traffic nuisances (short-term);
- The facilities may generate odor periodically. Municipal wastewater treatment facilities historically have been sources of odor. It is doubtful whether such odors can ever be completely eliminated at all times (long-term);
- Some water quality degradation due to erosion and discharge of increased suspended sediments would be associated with construction of treatment facilities and sewers. Principal adverse effects of this temporary siltation probably pertain more to aesthetic degradation than habitat degradation in the receiving streams (short-term);
- Hydraulic impact associated with a gradual increase in streamflows downstream of an expanded Village Creek WWTF are unavoidable. However, these impacts are expected to be minor (long-term);
- A slight loss of floodplain storage capacity due to increases in impervious cover in watersheds experiencing urbanization supported by system expansion would occur (long-term); and
- Some disturbance of vegetation and wildlife habitat at the Village Creek WWTF site, sludge disposal site and along pipeline routes would occur (short-term and long-term).

5.14.4 Irretrievable and Irreversible Resource Commitments

Implementation of any of the four final alternatives would require irreversible resource commitments. The resource commitments would include:

- Fossil fuel, electrical energy and human labor for facilities construction and operation;
- Chemicals, especially chlorine, for Village Creek WWTF operation;
- Tax dollars for construction and operation;
- Utilization of some unsalvagable construction materials; and
- Land devoted to development induced by the Fort Worth system expansion would not be available for other uses, at least for the life of the facilities.

5.14.5 Relationship Between Short-Term Uses Of Man's Environment and Maintenance and Enhancement of Long-Term Productivity

The short-term disruption and commitment of resources associated with construction and operation of the Village Creek WWTF would be necessary to improve water pollution control. Environmental impacts and resource requirements, however, would be offset by water quality improvements in the West Fork Trinity River. Long-term, significant environmental benefits would be derived from short-term, environmental and economic costs.

6.0 COORDINATION

This EIS process has included a "full scale" public participation program through which residents, public officials, and other interested parties in the planning area have been involved in identifying and evaluating major issues, assimilating public viewpoints and preferences, and demonstrating that those opinions and ideas have been considered fully by the decision-making official. Disagreement on significant issues will occur among government agencies and diverse groups interested in and affected by pending decisions. However, public agencies have encouraged full presentation of issues at an early stage so that they could be discussed and decisions could be made. During the course of this project, responsible officials have made efforts to ensure that participation by citizens who are both directly and indirectly affected by the proposed project was possible.

6.1 PUBLIC PARTICIPATION ACTIVITIES

The activities discussed below were planned and conducted throughout this project to maximize interaction with all affected parties. A public participation work plan was developed that presented proposed mechanisms to involve the Citizens Advisory Committee (CAC) and the general public in the facilities planning effort and EIS process.

6.1.1 Scoping Meeting

A formal scoping meeting was held by EPA on 15 August 1979 to inform citizens early about the Facilities Planning and EIS processes, and regulatory procedures. The scoping meeting also provided a forum to allow citizens to identify issues and present concerns from all parties for consideration in the EIS.

Concerns raised by those attending the meeting were as follows:

- Sources of odors and effectiveness (or lack thereof) of methods to control odors at the existing Village Creek WWTP;
- Correction of existing odor problems before any possible expansion at the existing site and assurance that new facilities would not aggravate the odor problem;

- Impacts of existing and potential future odors and insect problems on property values and tax base;

- Problems with local zoning and development encroaching on the existing plant site;

- Importance of considering alternative methods of sludge handling and disposal with an emphasis on a system that reduces odor;

- Importance of considering all feasible wastewater management alternatives and alternatives to further expansion of the existing Village Creek WWTF (i.e., abandoning existing WWTF and developing an alternative system);

- Importance of evaluating each alternative in regard to potential impacts on:
  - water quality
  - air quality (including odors)
  - biological resources
  - socioeconomic infrastructure (including property values, land use, zoning, public services, tax base, community growth, etc.)
  - public health
  - ambient noise levels
  - recreation

- Need for project to comply with appropriate environmental laws and regulations;

- Need for all alternatives considered to be cost effective;

- Need for proposed program to be consistent with areawide water quality management planning;

- Need to enforce current regulations for operation and wastewater discharge from the existing Village Creek WWTP before any expansion plans are implemented;

- Importance of assuring an adequate level of trained operation and maintenance staff at the Village Creek WWTP; and

- Need for expanded wastewater treatment to accommodate planned growth and development.

Primary concerns identified by residents living near the existing Village Creek WWTF focused on odor, insect, and noise problems. Many nearby residents expressed the opinion that odor problems were evidence that the existing plant was not being operated effectively and that further expansion would only compound existing problems. Other citizens cited the need for expansion of wastewater treatment facilities, if Fort Worth and surrounding communities are to experience continued growth and development.

6.1.2 Public Meetings/Responsiveness Summaries

A series of public meetings were held during the EIS process, including the scoping meeting. Notice of each public meeting was published in local newspapers prior to the meeting, and several hundred announcements were mailed to individuals identified as having an interest in the project. As discussed, the scoping meeting conducted by EPA Region 6 provided a forum to discuss the planning and EIS processes and was a means for citizens to raise issues of concern. The next two public meetings were held by the City of Fort Worth. At a public meeting held on 2 July 1981, presentations were made on current construction activities at the Village Creek WWTF, status of facilities planning efforts to date, development of preliminary alternatives, environmental screeening procedures used to evaluate the preliminary alternatives, results of the environmental screening and description of 15 intermediate alternatives, and results of independent studies on Fort Worth's wastewater management system.

Following descriptions of the 15 intermediate alternatives recommended by the CAC, comments and statements were received from the audience and entered into the meeting record. Key issues identified by the public generally can be summarized as follows:

- The public is supportive of the concept of land treatment of sewage;
- The public continues to be concerned about odors generated by the existing Village Creek WWTF; and
- The public is interested in issues of water quality and water rights.

The City responded to the public's concerns via a "responsiveness summary" to Public Meeting 2 which was distributed to all persons and agencies on the EIS mailing lists, and also placed in public information depositories.

Public Meeting 3 was held on 13 May 1982 to describe three final action alternatives (i.e., Alternatives 1, 2A, and 3) and to receive public comment. Three final alternatives were selected from 15 intermediate alternatives presented at the second public meeting. Descriptions of the three final alternatives and an engineering and environmental evaluation of each alternative were given. Following formal presentations, written and oral statements/responses were received from the audience. Concerns voiced by the public could be grouped according to major geographical areas of impact as follows:

(1) Concerns related to the Village Creek WWTF site.

(2) Concerns related to the 60,000-acre sludge landspreading/landfilling target zone located north of Saginaw, Texas.

(3) Concerns related to the Mustang Creek land treatment site.

The City's responses denoting how each concern would be handled were presented in a detailed "responsiveness summary" to Public Meeting 3 which was distributed and placed in public information depositories on 27 July 1982.

Public meetings also were held in the communities of Godley and Venus, Texas. Areas near these communities were being considered as sites for a land treatment of wastewater. The site near Godley was in one of the three final alternatives under consideration. Meetings were held to explain to citizens in the area details of land treatment and provide citizens with an opportunity to express their opinion about the project. Holding meetings in the actual areas to be affected by land treatment alternatives helped to ensure public awareness and involvement.

A formal public hearing also will be conducted by the City of Fort Worth and EPA on the City's draft facilities plan and Draft EIS. Presentations will be given on the proposed project and its associated environmental effects. The hearing also will provide an opportunity for public comment on the draft facilities plan and the Draft EIS.

6.1.3 Public Information Depositories

Three public information depositories were provided to promote public access to and awareness of on-going EIS and facilities planning activities for the City of Fort Worth. Locations of the public information depositories are as follows:

- North Central Texas Council of Governments
  1201 North Watson Road at Highway 360
  Arlington, Texas
  (817)640-3300

- Arlington Public Library
  101 East Abram
  Arlington, Texas
  (817)275-2763

- Fort Worth Public Library
  300 Taylor Street
  Fort Worth, Texas
  (817)870-7701

Information on file at these locations included both general and project-specific information. A summary of information that is available to the public at each of the public information depositories is presented in Table 6-1. In addition to information on water quality, Federal regulations, and the EIS process, minutes of all Citizens Advisory Committee meetings and technical status reports also are provided.

6.1.4 Citizens Advisory Committee

A CAC was formed to provide input to the City of Fort Worth on development and selection of feasible wastewater management alternatives. The membership of the CAC originally was composed of 40 members from the planning area with approximately an equal representation of private citizens, citizens with substantial economic interest, public officials, and representatives of public interest groups. A list of CAC members appointed by the City of Fort Worth and approved by EPA is provided in Table 6-2. During the project, several members resigned from the CAC and were replaced with others to maintain an appropriate balance. In addition, several new members were added to provide representation from outlying geographic areas that potentially could be affected by alternatives. Composition of the CAC is consistent with EPA's public participation regulations and was approved by EPA Region 6.

6-1. INFORMATION FILED AT PUBLIC INFORMATION DEPOSITORIES

(1) GENERAL INFORMATION

USEPA Pamphlets
- Maintaining Clean Water
- The Public and Construction Grants
- In Productive Harmony
- Growth and Environment

USEPA Booklets and Reports
- Final Environmental Impact Statement - Fort Worth, Texas (1973)
- National Municipal Policy and Strategy
- A Guide to the Clean Water Act Amendments
- A Primer of Wastewater Treatment (A-107)

(2) REGULATIONS

Federal Register
- Municipal Wastewater Treatment Works - 27 September 1978, Part III
- Public Participation in Programs Under the Resource Conservation and Recovery Act, The Safe Drinking Water Act, and the Clean Water Act - Final Regulations - 16 February 1979, Part V
- State and Local Assistance - Grants for Construction of Treatment Works - 16 February 1979, Part VI
- Council of Environmental Quality Regulations (40 CFR Parts 1500-1508)

(3) GUIDELINES FOR CITIZENS INVOLVEMENT

USEPA Publications
- Environmental Assistance - A Guide for Your Community
- Municipal Wastewater Management - Citizens Guide to Facility Planning
- Municipal Wastewater Management - Public Involvement Activities Guide

Pennsylvania State University (Prepared for USEPA)
- Role of Advisory Groups

(4) TECHNICAL SCOPE OF WORK FOR EIS (WAPORA, INC.)

WAPORA, Inc.
- Revision #2 - Scope of Work for Preparation of a Piggyback 201 EIS for the City of Fort Worth Wastewater Treatment System. Proposal #79-159(R)

(5) FINAL PUBLIC PARTICIPATION WORK PLAN

WAPORA, Inc.
- Village Creek Wastewater Treatment Facility, Fort Worth, Texas, Full-Scale Public Participation Work Plan (Final)

6-1. INFORMATION FILED AT PUBLIC INFORMATION DEPOSITORIES (CONCLUDED).

(6) ANNOUNCEMENTS AND ASSOCIATED HANDOUTS FOR CAC AND PUBLIC MEETINGS

(7) MINUTES OF CAC MEETINGS

(8) RESPONSIVENESS SUMMARIES TO PUBLIC MEETINGS

(9) TECHNICAL STATUS REPORTS - FACILITIES PLANNER

(10) PROGRESS REPORTS ON EIS

(11) EPA NOTICE OF INTENT TO PREPARE AN EIS

(12) DRAFT EIS AND DRAFT FACILITIES PLAN

TABLE 6-2 CITIZEN ADVISORY COMMITTEE MEMBERS AND THEIR RESPECTIVE CLASSIFICATIONS

- PRIVATE CITIZENS
  - Mrs. Walter Barbour
  - Larry L. Blackman, Vice Chairman
  - Comer Clay
  - David Frinfrock
  - Johnnie Hawkins
  - J. Foster Parsell
  - Steve Rodakovich
  - Wayne Wilson

- Citizens With Substantial Economic Interests
  - Warren Albertson
  - Claud R. Arnold
  - Bob Brown
  - John J. Burgess, Chairman
  - Roy Carrell
  - George Cloyd
  - Marshall E. Gish
  - W.B. Grove
  - C.C. Makarwich
  - Norman Robbins
  - Rudy Rodriquez
  - Richard P. Scaling

- Public Officials
  - Bob Brewer
  - Allen Bronstad
  - Jim Craig
  - Clifton Dobbins III
  - Dewey Markham
  - J.H. LaFaver
  - James R. McMeans
  - Robert T. McDaniel
  - Joe Potthoff
  - Charles R. Stringer

- Public Interest Groups
  - H. Carter Burdett
  - William Craighead
  - Paul Dilena
  - Lynda Gearheart
  - Mark Hill
  - Erma C. Johnson
  - Mrs. Howard McMahan
  - Mrs. John M. Michie
  - William C. Pannell
  - Mrs. James T. Ward

A total of thirteen CAC meetings and two subcommittee meetings have been held. Dates and key topics of discussion for each meeting are summarized in Table 6-3. CAC meetings are open to the public and complete minutes of each CAC meeting are available for public review at the public information depositories.

6.1.5 Other Public Participation Activities

In addition to the public participation activities discussed above, a series of project newsletters were published and of other interest groups as well as local, state, and Federal agencies were invloved in the public participation program. The City of Arlington, Texas provided considerable input to citizen awareness through reports, written handouts, oral presentations, and films on key topics of interest. In addition, the consulting firms of Sheaffer and Roland, Inc. and Agro-City were hired by the City of Arlington to study land treatment alternatives. Findings of these studies were made available to all interested parties. One of the three final alternatives (Alternative 3) includes land application as a component for treating and disposing of a portion of Fort Worth's wastewater. In relation to this, citizen groups sponsored tours of potential project sites in order to help evaluate alternatives, and the Fort Worth City Council also invited Sheaffer and Roland to present a full explanation of the land treatment alternatives at a regularly scheduled City Council meeting.

6.2 COOPERATING AGENCIES

Many local, state, and Federal agencies were consulted and provided technical assistance throughout the planning process. Agencies that provided substantive input include, but are not limited to, the following:

- Fort Worth Department of Public Works
- Fort Worth Planning Department
- Fort Worth Water Department

TABLE 6-3. SUMMARY OF CITIZEN ADVISORY COMMITTEE MEETINGS

CAC MEETING	DATE	KEY ACTIVITES
1	14 September 1979	• Organizational Meeting • Develop Lines of Communication • Establish Roles and Define Operating Procedures • Elect CAC Officers
2	30 November 1979	• Review Facilities Plan Status Report No. 2 • Review EIS/FP Process • Discuss Purpose and Content of EIS
3	11 January 1980	• Review Status of FP/EIS • Review Draft PP Work Plan • Briefing on Village Creek WWTP Operations, Problems, and Status of Improvements • Site Tour to Village Creek WWTP
4	9 May 1980	• Status Reports on EIS/FP • Status Report on Construction at Village Creek WWTP • Training Workshop in Public Participation • Detailed Briefing on Construction Grants Program
5	12 December 1980	• Status Reports on Preliminary Alternatives Development; I/I Analysis • Status Report on EIS • Report of Independent Consultant's Findings on Land Treatment • Report of Investigations on Water Quality Management • Review of Public Participation Program
6	10 April 1981	• Description of Preliminary Alternatives • Description of Environmental Evaluation Criteria for Screening Preliminary Alternatives • Presentation of a Study on Land Treatment Conducted by the City of Arlington • Update on FP/EIS Schedule

TABLE 6-3. SUMMARY OF CITIZEN ADVISORY COMMITTEE MEETINGS (CONTINUED)

CAC MEETING	DATE	KEY ACTIVITES
CAC Subcommittee Meeting #1	30 April 1981	• Workshop for Subcommittee on Screening of Preliminary Alternatives
7	14 May 1981	• Report from Subcommittee on Alternatives Screening • Discuss/Approve Revised Draft PP Work Plan • Environmental Screening of Preliminary Alternatives • Preparation of Recommendations by CAC Concerning Alternatives Selected for Further Evaluation
8	27 August 1981	• Presentation of Facilities Plan Status Report on Intermediate Alternatives • Discussion of Issues Raised at Public Meeting No. 2 • Discussion of CAC Budget • Present Revised FP/EIS Schedule
9	19 November 1981	• Briefing on Current Activities at the Village Creek WWTP; EPA Administrative Orders; Trial Studies Regarding Land Injection of Sewage Sludge • Explanation of 15 Intermediate Alternatives • Discussion on Revision/Additions to CAC Membership to Represent New Areas; Procedures for Evaluating Intermediate Alternatives
CAC Subcommittee Meeting #2	3 December 1981	• Discussion of Intermediate Alternatives • Briefing on Inter-Basin Transfer • Screening of Intermediate Alternatives
10	17 December 1981	• Report on TRA Transfer of Wastewater • Screening of Intermediate Alternatives • Briefing on Legal Findings (Water Rights) • Report from Subcommittee

TABLE 6-3. SUMMARY OF CITIZEN ADVISORY COMMITTEE MEETINGS (CONCLUDED).

CAC MEETING	DATE	KEY ACTIVITES
11	25 March 1982	• Discussion of Three Optimal Action Alternatives • Updated Schedule for FP/EIS
12	6 May 1982	• Film on Land Treatment • Engineering/Environmental Evaluation of Three Final Alternatives • Development and Evaluation of Modified Land Treatment concepts
13	9 December 1982	• Presentation and Discussion of City's Proposed Alternative • Updated Schedule of Remaining Project Milestones

- City of Arlington
- North Central Texas Council of Governments
- Tarrant County
- Tarrant County Water Control and Improvement District Number 1
- Texas Department of Water Resources
- Texas Department of Health
- Texas Department of Highways and Public Transportation
- Texas Parks and Wildlife
- Texas State Historic Preservation Officer
- Advisory Council on Historic Preservation
- U.S. Army Corps of Engineers - Fort Worth District
- USDA Soil Conservation Service
- U.S. Fish and Wildlife Service

6.3 ON-GOING COORDINATION

Table 6-4 lists agencies, organizations, and individuals with which coordination has been ongoing and/or which will have an opportunity to review the Draft EIS. In addition, EPA sent notices to those on the mailing list identifying the upcoming availability of this Draft EIS. Recipients of the notice were asked to identify to EPA if they wished to receive a copy of either a summary or a complete Draft EIS. Public notices of availability of this Draft EIS and of a public hearing on this Draft EIS and the related draft facilities plan will appear in the Federal Register and in various newspapers. The Draft EIS also will be available for review at the following locations:

- U.S. Environmental Protection Agency Region 6
  Interfirst Two
  1201 Elm Street
  Dallas, TX 75270
- City of Fort Worth Water Department
  City of Fort Worth Administration Building
  1000 Throckmorton
  Forth Worth, TX 76101
- NCTCOG Library
  1201 North Watson Road at Highway 360
  Arlington, TX 76011

TABLE 6-4. MAILING LIST FOR THE DRAFT EIS ON THE FORT WORTH FACILITIES PLAN

Federal Agencies

Advisory Council on Historic Preservation
Federal Emergency Management Agency
US Army Corps of Engineers
US Department of Agriculture (USDA)
USDA Agricultural Stabilization and Conservation Serivce
USDA Farmer's Home Administration
USDA Soil Conservation Service
US Department of Commerce (USDOC)
UDOC Economic Development Administration
US Department of Energy
US Department of Health and Human Services
US Public Health Service
US Department of Housing and Urban Development
US Department of Interior (USDOI)
USDOI Fish and Wildlife Service
USDOI National Park Service
USDOI Geological Survey
US Department of Transportation (USDOT)
USDOT Federal Aviation Administration
USDOT Federal Highway Administration
Water Resources Council
Representative Jim Wright
Representative Tom Vandergriff
Representative Phil Gramm
Representative Martin Frost
Senator John Tower
Senator Lloyd Bentsen

State

Office of Planning and Budget
General Land Office
Texas Department of Water Resources
Texas Department of Health
State Department of Highways and Public Transportation
State Historic Preservation Officer
Texas Historical Commission
Texas Parks and Wildlife Department
Texas Air Control Board
Govenor Mark White

TABLE 6-4. MAILING LIST FOR THE DRAFT EIS ON THE FORT WORTH FACILITIES PLAN (CONCLUDED).

Local Agencies and Public Interest Groups

North Central Texas Council of Governments
Tarrant County
City of Arlington
City of Benbrook
City of Burleson
City of Crowley
City of Dalworthington Gardens
Village of Edgecliff
City of Everman
City of Forest Hill
City of Haltom
City of Hurst
City of Kennedale
City of Lake Worth
City of North Richland Hills
Town of Pantego
City of Richland Hills
City of River Oaks
City of Saginaw
City of Sansom Park
Tarrant County Municipal Utility District #1
Town of Westover Hills
City of Westworth Village
City of White Settlement
Trinity River Authority
D/FW Regional Airport Board
Tarrant County WCID No.1
Sportsmen's Clubs of Texas
Natural Resources Defense Council
American Wilderness Alliance
Audubon Society
Sierra Club
Texas Commission on Natural Resources
League of Women Voters
Beautify Texas Council
Environmental Coalition of North Central Texas
Save Open Space
Soil Conservation Society of America
Texas Environmental Coalition
Texas Water Conservation Association
National Conservancy - Texas Chapter

- Fort Worth Library
  300 Taylor Street
  Fort Worth, TX 76101

- Arlington Public Library
  101 East Abram
  Arlington, TX 76011

Copies of the complete Draft EIS or the summary of the Draft EIS can be obtained from Mr. Clinton B. Spotts, Regional EIS Coordinator, U.S. Environmental Protection Agnecy, Region 6, 1201 Elm Street, Dallas, Texas 75270, phone 214-767-9891.

The draft facilities plan will be released at approximately the same time as the Draft EIS and will be made available at each of the above locations. The public hearing on the Draft EIS will be conducted jointly with the City of Fort Worth public hearing on the draft facilities plan.

7.0 LIST OF PREPARERS

This EIS was prepared by WAPORA, Inc., for the US Environmental Protection Agency, Region 6 under a joint EIS preparation arrangement with the City of Fort Worth. The Director and Assistant Director of the Fort Worth Water Department, Mr. Les Robinson and Mr. James Scanlan, respectively, were responsible for Forth Worth coordination of environmental review activities. Members of the staff of TDWR also provided assistance in preparation of this document. Part of the information developed for this EIS was obtained from the City of Fort Worth Water Department and its engineering consultants, Camp Dresser and McKee, Inc., and Rady and Associates, Inc. Appreciation is expressed to these groups for information provided.

Key personnel from EPA, WAPORA, and GSW and Associates included:

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Name	Education	Experience	Responsibility
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WAPORA, INC.

Name	Education	Experience	Responsibility
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Risa Fisher	BE, Engineering	4	Alternatives Analysis; Effluent Reuse; Aesthetics
Donna Madras		9	Word Processing; Production
Rebecca Foster	BA	7	Word Processing; Production
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Roy Greer	MS, Biology	12	Terrestrial/Aquatic Biology; Threatened/ Endangered Species
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Name	Education	Experience	Responsibility
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Name	Education	Experience	Responsibility
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Howard Saxion	MS, Environmental Science	9	Public Participation
John Stacey, P.E.	MS, Civil Engineering	20+	Environmental Engineering; Cost-Effectiveness Analysis
Charles Wilmut, P.E.	MS, Civil Engineering	12	Subcontract Administrator; Engineering Review

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9.0 GLOSSARY

9.1 DEFINITIONS

Activated sludge process. A method of secondary wastewater treatment in which a suspended microbiological culture is maintained inside an aerated treatment basin. The microbial organisms oxidize the complex organic matter in the wastewater to carbon dioxide, water, and energy.

Advanced secondary treatment. Wastewater treatment more stringent than secondary treatment but not to advanced waste treatment levels.

Advanced waste treatment. Wastewater treatment to treatment levels that provide for maximum monthly average BOD_5 and TSS concentrations less than 10 mg/l and/or total nitrogen removal of greater than 50% (total nitrogen removal = TKN = nitrite and nitrate).

Aerobic. Refers to life or processes that occur only in the presence of oxygen.

Algal bloom. A proliferation of algae on the surface of lakes, streams or ponds. Algal blooms are stimulated by nutrient enrichment.

Alluvial. Pertaining to material that has been carried by a stream.

Ammonia-nitrogen. Nitrogen in the form of ammonia (NH_3) that is produced in nature when nitrogen-containing organic material is biologically decomposed.

Anaerobic. Refers to life or processes that occur in the absence of oxygen.

Aquifer. A geologic stratum or unit that contains water and will allow it to pass through. The water may reside in and travel through innumerable spaces between rock grains in a sand or gravel aquifer, small or cavernous openings formed by solution in a limestone aquifer, or fissures, cracks, and rubble in harder rocks such as shale.

Artesian (adj.). Refers to ground water that is under sufficient pressure to flow to the surface without being pumped.

Artesian well. A well that normally gives a continuous flow because of hydrostatic pressure, created when the outlet of the well is below the level of the water source.

Average Daily Flow (ADF). The sum of base flow plus I/I. It is caluculated for each year by adding all recorded plant inflows and divided by 365. It is the general basis for plant design and yelds the average design capacity of a plant.

Base Flow. The expected flow if no Infiltration/Inflow (I/I) enters the system. This is needed to establish "pure" wastewater flows. It is the basis for all flow projections.

Bar screen. In wastewater treatment, a screen that removes large floating and suspended solids.

Biochemical oxygen demand (BOD). A bioassay-type procedure in which the weight of oxygen utilized by microorganisms to oxidize and assimilate the organic matter present per liter of water is determined. It is common to note the number of days during which a test was conducted as subscript to the abbreviated name. For example, BOD_5 indicates that the results are based on a five-day (120-hour) test. The BOD value is a relative measure of the amount (load) of living and dead oxidizable organic matter in water. A high demand may deplete the supply of oxygen in the water, temporarily or for a prolonged time, to the degree that many or all aquatic organisms are killed. Determinations of BOD are useful in the evaluation of the impact of wastewater and/or contaminated surface runoff on receiving waters.

Chemical oxygen demand (COD). A quick (and only approximate) measure of loads of oxidizable matter in water (in milligrams per liter) in which a strong oxidizing agent is used instead of microbial life. Like BOD, COD is an oxygen demand parameter; however, results cannot be used interchangeably with BOD values. COD can quickly identify water with very low or very high BOD potential.

Chlorination. The application of chlorine to drinking water, sewage or industrial waste for disinfection or oxidation of undesirable compounds.

Clarifiers. Mechanical devices for removal by gravity (settling out) of suspended particles in a liquid such as sewage.

Coliform bacteria. Members of a large group of bacteria that flourish in the feces and/or intestines of warm-blooded animals, including man. Fecal coliform bacteria, particularly Escherichia coli (E. coli), enter water mostly in fecal matter, such as sewage or feedlot runoff. Coliforms apparently do not cause serious human disease, but these organisms are abundant in polluted waters and they are fairly easy to detect. The abundance of coliforms in water, therefore, is used as an index to the probability of the occurrence of such disease-producing organisms (pathogens) as Salmonella, Shigella, and enteric viruses. The pathogens are relatively difficult to detect.

Comminutor. A machine that breaks up wastewater solids.

Community (biological). Plants and animals in a particular area that are closely related through food chains and other interactions.

Composting. A method of disinfecting sludge through microbial degradation using an aerobic metabolism in piles or windrows on a surfaced (paved) outdoor area.

Conductivity. The ability to carry an electrical charge, in ions. The conductivity of aqueous solutions is increased by dissolved salts and thus is a measure of the amount of ionized salts in solution.

Consumption. The amount of water that is evaporated or combined in a product and is no longer available for use.

Construction Grants Program. A program established by the Federal Water Pollution Control Act Amendments of 1972 allowing the Federal government to make grants available to states and /or municipalities for constructing publicly-owned wastewater treatment facilities.

Cost-effectiveness analysis. An analysis performed to determine which waste treatment management system or component part will result in the minimum total resources costs over time to meet Federal, State, or local requirements.

Cubic feet per second (cfs). Units used to measure flow; equals the rate of flow in a channel with a one-square-foot cross-section and velocity of one foot per second. One cfs for a 24-hour period equals 86,400 cubic feet or 1.98 acre-feet.

Cultural resources. Fragile and nonrenewable sites, districts, buildings, structures, or objects representative of our heritage. Cultural resources are divided into three categories: historical, architectural, or archaeological. Cultural resources of special significance may be eligible for listing on the National Register of Historic Places.

Dedicated land disposal (DLD). A method for the ultimate disposal of sludge through subsurface application to a finite land area which has limited public access and which has been set aside or dedicated for the disposal of wastewater sludge throughout the facilities planning period.

Detention time. Average time required to flow through a basin. Also called retention time.

Disinfection. Effective killing by chemical or physical processes of all organisms capable of causing infectious disease. Chlorination is the disinfection method commonly employed in sewage treatment processes, for disinfection of liquid wastewater effluents.

Dissolved air flotation. A method of thickening sludge which utilizes air to float sludge to the surface of the thickener, thereby reducing the water content and volume of the sludge.

Dissolved oxygen (DO). Oxygen gas (O_2) in water. It is utilized in respiration by fish and other aquatic organisms, and those organisms may be injured or killed when the concentration is low. Because much oxygen diffuses into water from the air, the concentration of DO is greater (other conditions being equal) at sea level than at high elevations; during periods of high atmospheric pressure rather than during periods of low pressure; and when the water is turbulent (during rainfall, in rapids, and waterfalls) rather than when it is placid. Because cool water can absorb more oxygen than warm water, the concentration tends to be greater at low temperatures than at high temperatures. Dissolved oxygen is depleted by the oxidation of organic matter and of various inorganic chemicals. Should depletion be extreme, water may become anaerobic.

Effluent. Wastewater or other liquid, partially or completely treated, or in its natural state, flowing out of a reservoir, basin, treatment plant, or industrial plant, or part thereof.

Effluent limited. In "effluent limited" river segments, water quality standards are currently being met or will be met when required effluent limitations are implemented.

Electron beam irradiation. A method of disinfecting sludge using a high voltage electrically operated machine which emits electrons. The electrons lose energy in collisions with atoms and molecules and produce ionization which causes disinfecting and detoxifying effects.

Eutrophication. The process of enrichment of a water body with nutrients.

Facilities plan. The principal technical planning document for proposed municipal wastewater collection and treatment. Preparation of a facilities plan is a prerequisite to funding through the EPA construction grants program.

Fauna. The total animal life of a particular geographic area or habitat.

Flora. The total plant life of a particular geographic area or habitat.

Force main. A pipe designed to carry wastewater effluent and/or wastewater sludge under pressure.

High efficiency particulate air filter (HEPA). A type of filter designed to remove 99.9 percent of particles down to 0.3 um in diameter from a flowing air stream.

Infiltration. Water entering a sewer system and service connections from the ground through such means as, but not limited to, defective pipes, pipe joints, improper connections, or manhole walls. Infiltration does not include, and is distinguished from, inflow.

Inflow. Water discharged directly into a wastewater collection system and service connections from such sources as, but not limited to, roof leaders, cellars, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross-connections from storm sewers and combined sewers, catch basins, storm waters, surface runoff, street wash waters or drainage. Inflow does not include, and is distinguished from, infiltration.

Influent. Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment facility, or any unit thereof.

Interceptor sewer. A sewer designed and installed to collect sewage from a series of trunk sewers and to convey it to a sewage treatment plant.

Lagoon. A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Land application. A final disposal method for sludge which utilizes the nutritive properties of sludge. Liquid, partially dewatered, or dried sludge is applied to already vegetated land or land that will be vegetated after application.

Landfilling. A method of disposing of sludge by burying sludge, often along with municipal garbage (termed codisposal), between layers of soil.

Lateral sewer. A sewer designed and installed to collect sewage from a limited number of individual properties and to convey it to a trunk sewer. Also known as a street sewer or collecting sewer.

Leachate. A solution or product obtained by leaching (i.e., a liquid percolating through a semi-solid mass). Typically, leachate is a contaminated wastewater stream.

Lift station. A facility in a sewerage system, consisting of a receiving chamber, pumping equipment, and associated drive and control devices, that pumps wastewater effluent or wastewater sludge through a force main to a subsequent pump station, treatment facility, or discharge point.

Loam. Soil mixture of sand, silt, clay, and humus.

Maximum Monthly Flow (MMF) or Nominal Design Flow (NDF). The highest average monthly flow during any one calendar year. It is determined by calculating the average daily flow for each month of the year (adding each daily flow and dividing by the number of days in the month) and picking the highest of the twelve values. This is also termed the Nominal Design Flow.

Milligram per liter (mg/l). A concentration of 1/1000 gram of a substance in 1 liter of water. Because 1 liter of pure water weighs 1,000 grams, the concentration also can be stated as 1 ppm (part per million, by weight). Used to measure and report the concentrations of most substances that commonly occur in natural and polluted waters.

National Register of Historic Places. Official listing of the cultural resources of the Nation that are worthy of preservation. Listing on the National Register makes property owners eligible to be considered for Federal grants-in-aid for historic preservation through State programs. Listing also provides protection through comment by the Advisory Council on Historic Preservation on the effect of Federally financed, assisted, or licensed undertakings on historic properties.

Nitrate-nitrogen. Nitrogen in the form of nitrate (NO_3). It is the most oxidized phase in the nitrogen cycle in nature and occurs in high concentrations in the final stages of biological oxidation. It can serve as a nutrient for the growth of algae and other aquatic plants.

Nitrite-nitrogen. Nitrogen in the form of nitrite (NO_2). It is an intermediate stage in the nitrogen cycle in nature. Nitrite normally is found in low concentrations and represents a transient stage in the biological oxidation of organic materials.

Non-point source. Any area, in contrast to a pipe or other structure, from which pollutants flow into a body of water. Common pollutants from non-point sources are sediments from construction sites and fertilizers and sediments from agricultural soils.

Nutrient. An element or compound required by an organism for growth and/or sustenance. Commonly, when referring to water quality, "nutrient" specifically means phosphorus and nitrogen.

Oxidation lagoon. A process for the prolonged detention of sewage in shallow ponds. Natural (as opposed to mechanically induced) contact with air is designed to support aerobic microorganisms which digest sewage.

Pasteurization. A method of disinfecting sludge by heating the sludge to temperatures (160°F - 195°F) that destroys pathogenic organisms.

Pathogenic organisms. Organisms, usually microscopic in size (e.g., bacteria and viruses), that may cause disease in the host organisms by their parasitic growth.

Peak 2 Hour Flow. The average flow rate which occurs during the 2-hour period when the highest flow rate occurs. It is needed to design the maximum hydraulic capacity of a plant.

Percolation. The downward movement of water through pore spaces or larger voids in soil or rock.

Photochemical oxidants. Secondary pollutants formed by the action of sunlight on nitric oxides and hydrocarbons in the air; they are the primary components of photochemical smog.

Piezometric level. An imaginary point that represents the static head of groundwater and is defined by the level to which water will rise.

Plankton. Minute plants (phytoplankton) and animals (zooplankton) that float or swim weakly in rivers, ponds, lakes estuaries, or seas.

Point source. In regard to water, any pipe ditch, channel, conduit, tunnel, well, discrete operation, vessel or other floating craft, or other confined and discrete conveyance from which a substance considered to be a pollutant is, or may be, discharged into a body of water.

Polychlorinated biphenols (PCBs). A group of organic compounds used especially in the manufacture of plastics. In the environment, PCBs exhibit many of the same characteristics as DDT and may, therefore, be confused with that pesticide. PCBs are highly toxic to aquatic organisms, they persist in the environment for long periods of time, and they are biologically magnified.

Polymers. Chemicals used in the conditioning of sludge which react with fine particles in the waste and assist in bringing them together into larger and heavier masses for settling.

Present worth. The equivalent worth (or value) at the present time of a proposed payment system involving present lump sum payments, future lump sum payments, and/or a series of payments (e.g., operating expenses) over a period of time.

Pressure filter (filter press). A method of dewatering sludge by pressing the sludge over a filter cloth.

Primary sludge. The solids removed from the bottom of a primary clarifier.

Primary treatment. The first stage in wastewater treatment, in which substantially all floating or settleable solids are mechanically removed by screening and sedimentation.

Secondary treatment. The second stage in the treatment of wastewater, in which bacteria are utilized to decompose organic matter in sewage. This step is accomplished by introducing the sewage into a biological treatment unit (e.g., a trickling filter or an activated sludge process). Effective secondary treatment processes remove virtually all floating solids and settleable solids, as well as 90% of the BOD and suspended solids. USEPA regulations define secondary treatment as 30 mg/l BOD, 30 mg/l SS, or 85% removal of these substances.

Sewage. A combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants and/or institutions; wastewater.

Sludge. The accumulated solids that have been separated from liquids such as wastewater.

Supernatant. Relatively clear liquid that can be withdrawn from the top of the tank (e.g., anaerobic digestors) and recycled to the treatment plant.

Suspended solids (SS). Small solid particles that contribute to turbidity. The examination of suspended solids and the BOD test constitute the two main determinations for water quality that are performed at wastewater treatment facilities.

Trickling filter process. A method of secondary wastewater treatment in which the biological growth is attached to a fixed medium, over which wastewater is sprayed. The filter organisms biochemically oxidize the complex organic matter in the wastewater to carbon dioxide, water, and energy.

Turbidity. Defined as capacity of material suspended in water to scatter light. Measured in arbitrary Jackson turbidity units (JTU), or more recently, Formazin turbidity units (FTU). Highly turbid water is often called "muddy", although all manner of suspended particles contribute to turbidity.

Wastewater. The spent water of a community. A combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants and/or institutions; sewage.

Water quality. The relative condition of a body of water, as judged by a comparison between contemporary values and certain more or less objective standard values for biological, chemical, and/or physical parameters. The standard values usually are based on a specific series of intended uses, and may vary as the intended uses vary.

Water table. The upper level of groundwater that is not confined by an upper impermeable layer and is under atompsheric pressure. The upper surface of the substrate that is wholly saturated with groundwater.

9.2 STANDARD ACRONYMS, ABBREVIATIONS, AND UNITS

ACHP. Advisory Council on Historic Preservation.

ADF. Average Daily Flow.

Ag. Silver.

Al. Aluminum.

AQCR. Air Quality Control Region.

As. Arsenic.

Ba. Barium.

BACT. Best Available Control Technology. A regulatory air pollutant emissions limitation based on the maximum degree of reduction of a particular pollutant, taking into account energy, environmental, and economic impacts.

BCY. Bank cubic yards.

Be. Beryllium.

BOD. Biochemical oxygen demand.

BP. Before Present; indicates time in radiocarbon years before AD 1950.

Btu. British thermal unit. The quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2°F.

Ca. Calcium.

CAC. Citizens Advisory Committee.

CAM. Continuous Automated Monitor.

Cd. Cadmium.

CDM. Camp, Dresser and McKee, Inc. Consulting Engineers.

cfs. Cubic feet per second.

City. The City of Fort Worth, Texas.

cm. Centimeter.

COD. Chemcial oxygen demand.

Co. Cobalt.

COE. Corps of Engineers (also USCOE).

Cr. Chromium.

Cu. Copper.

CWA. Clean Water Act.

Cy. Cubic yard.

dbA. The sound level obtained by the use of A-weighting. The unit is the decibel, db, and is followed by the letter A to indicate A-weighting. The A-weighting network best simulates the human ear's response to sound pressure.

DO. Dissolved oxygen.

EIS. Environmental Impact Statement.

EPA (or USEPA). United States Environmental Protection Agency.

FAA. Federal Aviation Administration.

Fe. Iron.

FEMA. Federal Emergency Management Agency.

ft. Feet.

FWS. United States Fish and Wildlife Service.

g. Gram.

gpd. Gallons per day.

gpm. Gallons per minute.

H. Hydrogen.

ha. Hectare.

Hg. Mercury.

I/I. Infiltration/Inflow.

in. Inches.

K. Potassium.

kg. Kilogram.

km. Kilometer.

KV. Kilovolt.

kwh. Kilowatt hour.

l. Liter.

L_{eq}. L equivalent.

m. Meter.

mg. Milligram.

Mg. Magnesium.

mgd. Million gallons per day.

mg/l. Milligrams per liter.

mi. Miles.

MJ. Megajoule.

mm. Millimeter.

MMF. Maximum Monthly Flow.

Mn. Manganese.

Mo. Molybdenum.

msl. Mean sea level. The average height of the sea for all stages of the tide.

Na. Sodium.

NAAQS. National Ambient Air Quality Standards.

NCTCOG. North Central Texas Council of Governments.

NDF. Nominal Design Flow.

NEPA. National Environmental Policy Act.

Ni. Nickel.

NO_x. A combination of various oxides of nitrogen, the most common of which are nitric oxide (NO) and nitrogen dioxide (NO_2). Formed by combustion processes.

NPDES. National Pollutant Discharge Elimination System. The permitting system authorized under Section 402 of the Clean Water Act, including any state or interstate program that has been approved by the Administrator, in whole or in part, pursuant to Section 402.

NWS. National Weather Service.

O&M. Operation and Maintenance.

Pb. Lead.

pH. The measure of hydrogen-ion activity in solution. Expressed on a scale of 0 (highly acid) to 24 (alkaline) pH 7.0 is a neutral solution, neither acid nor alkaline.

ppm. Parts per million. One part by weight of dissolved chemical or suspended sediment in one million parts by weight of water.

PSD. Prevention of Significant Deterioration.

Rady. Rady and Associates, Inc. Consulting Engineers.

RBC. Rotating Biological Contactors.

SCS. Soil Conservation Service.

Se. Selenium.

sec. Second.

SHPO. State Historic Preservation Officer.

SMSA. Standard Metropolitan Statistical Area.

SO_2. Sulfur dioxide - a gaseous air pollutant that is produced primarily by the combustion of fossil fuels and petroleum refining.

TDHPT. Texas Department of Highways and Public Transportation.

TDS. Total Dissolved Solids. The anhydrous residues of dissolved constituents in water. Actually, the term is defined by the method used in determination. Standard methods are used in water and wastewater treatment.

TDWR. Texas Department of Water Resources.

TPD. Tons per day.

TPW. Texas Parks and Wildlife Department.

TPY. Short tons per year.

TRA. Trinity River Authority.

TSP. Total suspended particulates existing in the form of minute separate particles. Suspended particulates are measured by drawing a known volume of air through a filter of known weight and reweighing the filter.

TSS. Total suspended solids. The sum of solids that either float on the surface or are in suspension in water, wastewater, or other liquids. These can be removed by filtering.

ug. Microgram; one millionth of a gram.

USCOE. United States Corps of Engineers (also COE).

USDA. United States Department of Agriculture.

USDHHS. United States Department of Health and Human Services.

USEPA. United States Environmental Protection Agency (also EPA).

USFWS. United States Fish and Wildlife Service.

USGS. United States Geologic Survey.

USPHS. United States Public Health Service.

V. Vanadium.

VCWWTF. Village Creek Wastewater Treatment Facility, Fort Worth TX.

WRC. Water Resources Council.

WWTF. Wastewater Treatment Facility.

Zn. Zinc.

APPENDIX A

Significant Correspondence

IN REPLY REFER TO:

SE

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

REC[illegible]
OC[illegible] 1979

October 11, 1979

Mr. Clinton B. Spotts
Regional EIS Coordinator
U.S. Environmental Protection Agency
1201 Elm Street
Dallas, Texas 75270

Dear Mr. Spotts:

This is in reply to your September 17, 1979 letter which requested information about species which are listed or proposed to be listed as threatened or endangered as provided by the Endangered Species Act. Your area of interest is Fort Worth, Texas.

As provided by Section 7(c) of the Endangered Species Act Amendments of 1978, the Fish and Wildlife Service is required to furnish a list of those species, both proposed and listed that may be or are present in the area involving Federal construction activities.

Upon receipt of the Fish and Wildlife Service's species list, the Federal agency authorizing, funding, or carrying out the construction action is required to conduct a biological assessment for the purpose of identifying listed species which are likely to be affected by such action. Proposed species are included on the list even though they do not have legal protection under the Act. Their inclusion recognizes that they may be listed anytime and have the portent to cause delays or modifications to the proposed action. In light of this, we recommend that those species be included in the biological assessment.

The biological assessment shall be completed within 180 days after receipt of the species list, unless it is mutually agreed to extend this period. The biological assessment should include: 1) the results of a comprehensive survey; 2) results of any studies undertaken to determine the nature and extent of any impacts on identified species; 3) consideration of the cumulative effects upon the species or its critical habitat; 4) study methods used; 5) difficulties encountered in obtaining data and completing the proposed study; 6) conclusions including recommendations as to further studies, and 7) any other relevant information.

CONSERVE AMERICA'S ENERGY

Save Energy and You Serve America!

For purposes of providing interim guidance, the Fish and Wildlife Service considers construction projects to be any action conducted or contracted by the Federal agency designed primarily to result in the building or erection of man-made structures, such as dams, buildings, roads, pipelines, and the like. This includes consideration of major Federal actions such as permits, grants, licenses, or other forms of Federal authorization or approval which may result in construction and which significantly affect the quality of the human environment. In addition, other actions that have the potential of becoming or are controversial, may be considered as construction.

If the biological assessment reveals that the proposed project may affect listed species, the formal consultation process shall be initiated by writing to the Regional Director, Region 2, U.S. Fish and Wildlife Service, P. O. Box 1306, Albuquerque, New Mexico 87103. If no affect is evident, there is no need for further consultation. We would, however, appreciate the opportunity to review your biological assessment.

The attached sheet provides information on species which may occur in the proposed project area. If we may be of further assistance, do not hesitate to call upon us (505-766-3972; FTS 474-3972).

Sincerely yours,

W O Nelson

Regional Director

Attachment

cc: Austin Area Office (SE), Austin, Texas
Field Supervisor, Ecological Services, Fort Worth, Texas

Fort Worth Wastewater Treatment Facilities

Tarrant County, Texas

LISTED SPECIES

None.

PROPOSED SPECIES

None.

CRITICAL HABITAT

None.

IN REPLY REFER TO:

SE

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

POST OFFICE BOX 1306
ALBUQUERQUE, NEW MEXICO 87103

December 10, 1981

RECEIVED
DIVISION

Mr. Clinton B. Spotts
Regional EIS Coordinator
U.S. Environmental Protection Agency
1201 Elm Street
Dallas, Texas 75270

Dear Mr. Spotts:

This is in reply to your letter of November 16, 1981, which requested information about species which are listed or proposed to be listed, as threatened or endangered, as provided by the Endangered Species Act. Your area of interest is the Fort Worth wastewater facilities in Tarrant and Johnson Counties, Texas.

Upon request, the Fish and Wildlife Service provides a list of those species, both proposed and listed, which may be affected by Federal construction activities.

Our data indicate no listed or proposed species would be affected by the proposed action in your area of interest. If I may be of further assistance, do not hesitate to call the Office of Endangered Species at (505) 766-3972 or FTS 474-3972.

Sincerely yours,

R. F. Stephens

Assistant Regional Director

cc: Phoenix Area Office, Phoenix, AZ
Ecological Services Field Office, Phoenix, AZ

TEXAS DEPARTMENT OF WATER RESOURCES
1700 N. Congress Avenue
Austin, Texas

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TEXAS WATER COMMISSION
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Felix McDonald
John D. Stover

May 27, 1983

RECEIVED

Dr. LaVerne Herrington
Deputy State Historic Preservation Officer
Texas Historical Commission
P. O. Box 12276, Capitol Station
Austin, Texas 78711

Dear Dr. Herrington:

Re: City of Fort Worth
C-48-1323

Enclosed is a report by Mr. Christopher Jurgens, Archeologist for the Construction Grants and Water Quality Management Division, Texas Department of Water Resources, detailing the results of a reconnaissance of proposed project elements in and around the city of Fort Worth. Three archeological sites were located, 41TR64, 41TR65, and 41TR66. Mr. Jurgens considered sites 41TR65 and 41TR66 to be significant and potentially eligible for nomination to the National Register of Historic Places (NRHP). As such, he recommended that they be avoided by construction or tested to determine their actual eligibility according to NRHP criteria. With these conditions, we request archeological clearance be granted by the State Historic Preservation Officer for this project.

Thank you for your cooperation. If you have any questions, please contact Mr. Jurgens at 475-6571.

Sincerely,

Rebecca S Motal

Emory G. Long, Director
Construction Grants and Water
Quality Management Division

CJJ:mc
Enclosure
cc: Mr. James Scanlan, City of Fort Worth Water Department
Mr. Presley Hatcher 6ES-FP, EPA Region VI
TDWR District No. 4

P. O. Box 13087 Capitol Station • Austin, Texas 78711 • Area Code 512/475-3187

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TEXAS HISTORICAL COMMISSION

CURTIS TUNNELL
EXECUTIVE DIRECTOR

P.O. BOX 12276
AUSTIN, TEXAS 78711
(512) 475-3092

June 23, 1983

RECEIVED
JUN 27 1983
6 ES

Mr. Emory G. Long, Director
Construction Grants and Water
Quality Management Division
Texas Department of Water Resources
1700 N. Congress Avenue
Austin, Texas 78711

Re: City of Fort Worth
C-48-1323

Dear Mr. Long:

We have reviewed the archeological report on the undertaking referenced above. We concur with the recommendations of the archeologist that 41TR65 and 66 are significant and should be avoided, if possible, by construction or tested to determine their eligibility for the National Register of Historic Places. With these conditions in mind, we recommend the project proceed.

Thank you for the opportunity to comment.

Sincerely,

Patience E. Patterson for
LaVerne Herrington, Ph.D.
Deputy
State Historic Preservation
Officer

PEP/LH/lft

cc: EPA, VI

The State Agency for Historic Preservation

APPENDIX B

Laboratory Analysis of Sewage Sludge

To Jean

INTER-OFFICE CORRESPONDENCE

TO M. Woolsey **DATE** May 1, 1981

FROM Calvin F. Ward, Laboratory Director
Chemist III

Received By: CC **Date:** 5/11/81

File:

SUBJECT Solid Waste Toxicity by EP Toxicity Tests **Copy to:**

Reference: June 27, 1980 Solid Waste Toxicity EP Toxicity Tests

The solid waste, as sampled from the Village Creek dyring beds, does not exceed any toxicity test limits as noted in the attached data sheets.

Two samples of the solid waste was analyzed by the protocol in Appendix 11-EP Toxicity Test Procedures, Federal Register/Vol. 45, No. 98/Monday, May 19, 1980/Rules and Regulations.

No toxic cyanide or sulfide was detected.

The 49CFR 173.51,49CFR 173.53, 49 CFR 173.88 or EPA Hazardous Waste Number of D003 was negative in all respects.

The solid waste from the Village Creek Wastewater Treatment Plant is not a hazardous waste or capable explosive decomposition as tested in our laboratories.

The tests of D004 through D011, Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Selenium, and Silver were analyzed by Perkin-Elmer 403 and 5000 Atomic Absorption Spectroscopy, as noted in the attached data. The contaminants are well below the maximum concentration as defined in EP Toxicity 261.24. Additional metal analysis since the previous report of June 27, 1980, as noted in the attached tables, reinforces the conclusion that VC solid waste is not a hazardous waste. However, toxic metals are present in low concentrations as noted in the attached data. Our active participation in the PreTreatment Program may show improvement in the low metal concentrations.

Pesticides analysis was accomplished using Tracor 550 Gas Chromatograph with the electron capture detector with nickel 93 source. The column and conditions were as noted in EPA-600/2-79-166 November 1979-Evaluation of Protocols and Pesticides and PCB's in Raw Wastewater. Mr. Terry Adams, Chemist II, Water Department was very helpful in making these tests. The samples were tested as no pesticides were detected.

The Solid Waste from the drying bed area of the Village Creek Wastewater Treatment did not exceed any maximum concentration as defined by the EP Toxicity Protocol.

May 1, 1981

As previously stated in the above reference, our solid waste product is subjected to activated aerobic digested sludge which undergoes anaerobic digestion of several days in length, which uses methane bacillus to manufacture methane gas, as well as secondary digestion in sealed digesters.

Calvin F. Ward

CALVIN F. WARD
CHEMIST II
CFW:jn
cc: J. L. Robinson ✓
Jim Scanlan
Ralph Hardy

CHARACTERISTICS OF EP TOXICITY
CONCENTRATION OF CONTAMINANTS

DATE MARCH 1981

EPA HAZARDOUS WASTE NUMBER	CONTAMINANT	CONCENTRATIONS (mg/L)		
		EPA Limit	SAMPLES 1	2
D 004	ARSENIC	5.0	0	0
D 005	BARIUM	100.0	58.2	27.4
D 006	CADMIUM	1.0	0.2	0.4
D 007	CHROMIUM	5.0	0.4	0.4
D 008	LEAD	5.0	3.8	2.4
D 009	MERCURY	0.2	0	0
D 010	SELENIUM	1.0	0.8	0.8
D 011	SILVER	5.0	0.6	0.8
D 012	ENDRIN (1,2,3,4,10,10-hexachloro-1,7 epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo,endo-5,8-dimethano naphthalene)	0.02	0	0
D 013	LINDANE (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer)	0.1	0	0
D 014	METHOXYCHLOR (1,1,1-trichloro-2,2-bis [p-methoxyphenyl] ethane)	10.0	0	0
D 015	TOXAPHENE ($C_{10}H_{10}Cl_{6}$, Technical chlorinated camphene, 67-69 percent chlorine)	0.5	0	0
D 016	2,4-D (2,4-Dichlorophenoxyacetic acid)	10.0	0	0
D 017	2,4,5-TP SILVEX (2,4,5-Trichlorophenoxypropionic acid)	1.0	0	0
CHARACTERISTICS OF REACTIVITY			Neg.	Neg.

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WP

ALLIED ANALYTICAL & RESEARCH LABORATORIES

Chemists

Consultants & Technologists

3031 Glenfield
P.O. Box 24330
Dallas, Texas 75224

214/337-8996

January 31, 1982

SAMPLE Sludge **DATE SUBMITTED** 1/15/82

IDENTIFYING MARKS See Below **ANALYTICAL REPORT NO.** 58717

SUBMITTED BY

Camp, Dresser & McKee, Inc.
Attn: Eric Schweizer, P.E.

ADDRESS

6060 North Central Expy
Suite 770
Dallas, Texas 75206

ANALYSIS

On January 18, 1982, two (2) sludge samples were submitted for analysis. The parameter of analysis were given by letter of January 11, 1982. The results of that analysis are shown below.

RESULTS

PARAMETER*	DIRT	SLUDGE
pH (No-units)	7.5	7.5
Total Solids @ 105^{o}, %	63.4	3.4
Volatile Solids (on Total Solids), %	30.3	50.5
Ammonia Nitrogen	0.12	0.78
Nitrites	2.11	<0.1
Nitrates	1.58	0.09
Organic Nitrogen	3.69	0.06
Total Kjeldahl Nitrogen	3.81	0.83
Cyanide	11.90	0.71
Phenol	0.68	0.46
PCB's	3.3 (1.7 ppm)	<0.1
Aluminum	17,920	601.3
Arsenic	4.1	0.5
Cadmium	51.9	1.5
Chromium	505.9	22.6

ALLIED ANALYTICAL & RESEARCH LABORATORIES, BY____________________

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ALLIED ANALYTICAL & RESEARCH LABORATORIES

Chemists

Consultants & Technologists

3031 Glenfield
P.O. Box 24330
Dallas, Texas 75224

214/337-8996

AMERICAN COUNCIL OF INDEPENDENT LABORATORIES, INC.

January 31, 1982

SAMPLE Sludge

DATE SUBMITTED 1/15/82

IDENTIFYING MARKS See Below

ANALYTICAL REPORT NO. 58717

SUBMITTED BY
Camp, Dresser & McKee, Inc.
Attn: Eric Schweizer, P.E.

ADDRESS
6060 North Central Expy
Suite 770
Dallas, Texas 75206

ANALYSIS

PARAMETER*	DIRT	SLUDGE
Copper	232.0	13.0
Iron	9140.1	726.6
Lead	196.1	5.9
Manganese	282.6	21.3
Mercury	0.062	0.001
Nickel	48.3	2.0
Zinc	1715.9	73.9
Total Organic Halogen	<1	<1

* Unless otherwise noted, all values milligrams/kitograms as received.

ALLIED ANALYTICAL & RESEARCH LABORATORIES, BY ______________________

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ALLIED ANALYTICAL & RESEARCH LABORATORIES

Chemists

Consultants & Technologists

3031 Glenfield
P.O. Box 24330
Dallas, Texas 75224

214/337-8098

AMERICAN COUNCIL OF INDEPENDENT LABORATORIES, INC.

January 31, 1982

SAMPLE	Sludge	**DATE SUBMITTED**	1/15/82
IDENTIFYING MARKS	See Below	**ANALYTICAL REPORT, NO.**	58717

SUBMITTED BY

Camp, Dresser & McKee, Inc.
Attn: Eric Schweizer, P.E.

ADDRESS

6060 North Central Expy
Suite 770
Dallas, Texas 75206

ANALYSIS

Pesticides/Herbicides

On EP Toxicity Extract

Parameter, milligram/liter	Dirt	Sludge
	Concentration	
Endrin	<0.01	<0.01
Lindane	<0.01	<0.01
Methoxychlor	<0.10	<0.10
Toxaphene	<0.01	<0.01
2, 4-D	<0.10	<0.10
2, 4, 5-TP (Silvex)	<0.02	<0.02

H. Morris Weller, President

ALLIED ANALYTICAL & RESEARCH LABORATORIES, BY

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APPENDIX C

USCOE Wetland Evaluation

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102

February 1, 1983

Office Operations Branch

Mr. James C. Varnell, P.E.
WAPORA, Inc.
8515 Greenville Avenue
Dallas, Texas 75243

Dear Mr. Varnell:

This is in response to your letter of 9 December 1982 requesting a wetland determination for the proposed Village Creek Wastewater Treatment Facility landfill, Fort Worth, Tarrant County, Texas.

The U.S. Army Corps of Engineers regulates the discharge of dredged or fill material into waters of the United States including adjacent wetlands under Section 404 of the Clean Water Act (CWA). The enclosed map details the areas within your project boundaries which fall under our jurisdiction. The discharge of fill material for such things as levees, roads, etc. will require our prior authorization. The discharge of sludge is regulated under Section 402 of the CWA and does not require a Department of the Army permit.

According to our records, you have already been supplied with a map of the 100-year floodplain by our Hydraulics Section. We are returning the unused base maps supplied by you.

If you have any questions concerning the wetlands determination or Section 404 permit requirements, you may contact Mr. Brooks Carter at 817-334-3551.

Sincerely,

L. M. Hawkins, Jr.
Chief, Office Operations Branch

Enclosures

Copy furnished:
Presley Hatcher
U.S. Environmental Protection Agency
6ES-FP
1201 Elm Street
Dallas, Texas 75270

RECEIVED
FEB 2 1983

U. S. ARMY CORPS OF ENGINEERS
WETLAND DETERMINATION

CITY OF FORT WORTH

VILLAGE CREEK WASTEWATER TREATMENT FACILITY

INTRODUCTION

The U.S. Army Corps of Engineers (COE) regulates the discharge of dredged and fill material into waters of the United States including adjacent wetlands under Section 404 of the Clean Water Act (CWA). The Regional Administrator of the United States Environmental Protection Agency (EPA) has ultimate authority to determine the reach of waters of the United States as described in the CWA. In accordance with the Memorandum of Understanding (MOU) with EPA concerning geographical jurisdiction of the Section 404 program, the COE has been requested by EPA to establish the boundaries of waters of the United States which do not involve significant issues or technical difficulties where EPA has declared a special interest.

The Village Creek Project in Tarrant County, Texas proposed by the City of Fort Worth does not involve any such special interest. WAPORA, Inc. has asked the COE to make this jurisdictional determination. This document is being prepared in accordance with the CWA, and its purpose is to detail the extent of the waters of the United States including adjacent wetlands in the proposed project area.

METHODS

A field investigation of the project was conducted on 22 December 1982 by representatives of the COE and EPA.

Transect lines were established at five sites and spot checks were made throughout the project area. These sites were selected on the basis of accessibility, representativeness, drainage characteristics and range of topographic changes. Their locations are shown on the accompanying maps.

Transects were extended into nonwetland areas to discern differcences in key characteristics and estimate a line of demarcation. Investigation along each transect included the identification of vegetative communities, examination of soils and observation of positive hydrologic indicators (i.e. flood debris, silt deposition on vegetation, standing water, etc.). The best correlation between these factors was established and this elevation was plotted on a topographic map as our limit of jurisdiction.

SUMMARY OF FIELD OBSERVATIONS

The forested wetlands are dominated by green ash and sugarberry in the overstory and by swamp privet and cedar elm in the understory. The herbaceous wetlands contain burhead, sedges, flat sedge, and cocklebur. The soil is a frequently flooded Trinity clay.

CONCLUSION

Wetlands are transition areas between the aquatic and terrestrial zone. Necessarily wetlands are at times wet and at other times dry. They are defined for purposes of our regulatory program, as those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted to life in saturated soil conditions. The prevalent vegetation which occurs in wetlands designated in this report has been shown by various studies to be flood tolerant. In addition most of these species maintain a competitive advantage in wet soils. It is significant that species known to have little tolerance to flooding did not occur within the wetlands. These wetlands principally occur in alluvial soil restricted to floodplains. The Soil Conservation Service has stated that flooding is the main limitation of using this soil for cropland.

It is my determination that the areas designated on the attached map (totaling 4.4 acres) and further described in Appendix A are wetlands consistent with the above definition and comprise a portion of the waters of the United States under our regulatory jurisdiction. In the absence of adjacent wetlands, the lateral limit of COE jurisdiction is the plane of the ordinary high water mark.

RECOMMENDED BY: Larry Buck DATE: 26 Jan 1983
Larry D. Buck
Chief, Permits Section

REVIEWED BY: DATE: 26 Jan 1983
L. M. Hawkins, Jr.
Chief, Office Operations Branch

FOR THE DISTRICT ENGINEER:

APPROVED BY: Allie J. Majors DATE: 27 January 1983
Allie J. Majors
Chief, Operations Division

APPENDIX A

The forest cover types used here are taken from the Society of American Foresters 1980 publication Forest Cover Types of the United States and Canada.

Site 1: This transect was started at the intersection of two dirt roads located 2300 feet from the intersection of Trammel-Davis Road and Bedford-Arlington Road at an azimuth of 197°. The transect was walked at 305° for 900 feet and then 288° for 1000 feet. A small depression which ponds water for long periods of time was encountered 140 feet into the transect (Figure 1). The species there are burhead, sedges, and cocklebur. Plants on the remainder of the transect include Johnson grass, an aster, ragweed, sugarberry, and common balloon-vine. The soil is a frequently flooded Trinity clay. Another depression is located at the end of the transect (Figure 2). The woody vegetation there is predominantly black willow and button bush but also present are osage orange and sugarberry. Herbaceous plants include sedges, flat sedge, rushes, and water-primrose. The area is semipermanently inundated and water is up to three feet deep.

Site 2: This area is located 300 feet from the starting point of site one at an azimuth of 230°. The small depression here (Figure 3) contains sedges, flat sedge, and cocklebur. Crayish and crayfish chimneys are present. The soil is a wet, very dark gray Trinity clay.

Site 3: This transect started at a point 1050 feet west of the outfall structures for the Village Creek Sewage Treatment Plant and was run at 265° for 500 feet. A depression with a forest cover type of sugarberry-American elm-green ash (93) (Figure 4) was encountered 265 feet into the transect. The dominant overstory species are green ash and sugarberry. Cottonwood and black willow are also present. The understory is almost completely swamp privet (Figure 5) but there are a few sugarberry and cedar elm seedlings. Duckweed is the common herbaceous species. The soil is a frequently flooded Trinity clay.

Above this depression the woody species include bur oak, cedar elm, white ash, and eastern redbud.

Site 4: This site is 900 feet west of the Village Creek Sewage Treatment Plant outfall structures. The area has been mined for top soil. The wall between the pit and the river eroded and the river now inundates the area on a frequent basis (Figure 6). The plants located in the bottom of the pit are predominantly black willow and flat sedge.

Site 5: This area is 500 feet south of the southeast corner of the current land fill levee. The woody species in the marshy depression are small cedar elm and black willow. Herbaceous species include cocklebur, common balloon-vine, sedges, flat sedge and smartweed. Standing water is present much of the time. The soil is a tan silt for the first four inches and below that is a very dark gray Trinity clay.

The higher elevations contain Johnson grass, honey locust, cedar elm, sugarberry, and cocklebur.

Reproduced from best available copy.

FORT WORTH DIST. **CORPS OF ENGINEERS** **FORT WORTH, TEXAS**

Photographer	Date	Location
Brooks Carter	December 22, 1983	Village Creek WWTF Proposed Landfill Site

The first depression encountered at Site 1. The light colored vegetation is almost entirely burhead.

Figure 1

FORT WORTH DIST. **CORPS OF ENGINEERS** **FORT WORTH, TEXAS**

Photographer	Date	Location
Brooks Carter	December 22, 1982	Village Creek WWTF Proposed Landfill Site

This is the second depression encountered at Site 1. The matted brown vegetation in the foreground is water primrose. Common buttonbush and black willow can be seen in the background. Old garbage trucks have been disposed of here.

Figure

SWF FORM 43-J
12 Jan 55

FORT WORTH DIST.	CORPS OF ENGINEERS	FORT WORTH, TEXAS
Photographer Brooks Carter	Date December 22, 1982	Location Village Creek WWTF Proposed Landfill Site

Site 2. The depression is nearly dry at the time of this picture. A week later following a rain, the area was full of water.

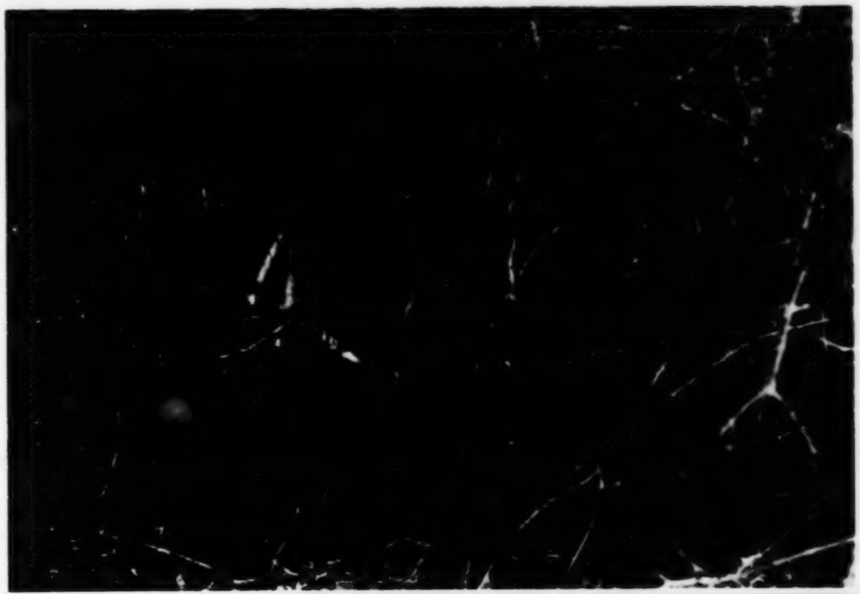
Figure 3

FORT WORTH DIST.	CORPS OF ENGINEERS	FORT WORTH, TEXAS
Photographer Brooks Carter	Date December 22, 1982	Location Village Creek WWTF Proposed Landfill Site

Picture taken standing on high ground looking toward the start of the depression at Site 3.

Figure 4

SWF FORM 43-J
12 Jan 55



FORT WORTH DIST.	CORPS OF ENGINEERS	FORT WORTH, TEXAS
Photographer Brooks Carter	Date December 22, 1982	Location Village Creek WWTF Proposed Landfill Site

Seen growing in the standing water at site 3 is a thick stand of swamp privet.

Figure 5

FORT WORTH DIST.	CORPS OF ENGINEERS	FORT WORTH, TEXAS
Photographer Brooks Carter	Date December 22, 1982	Location Village Creek WWTF Proposed Landfill Site

This picture was taken looking east. The hole eroded in the river bank can be seen in the right rear of the picture in the area of the fallen trees.

Figure 6

SWF FORM 43-J
12 Jan 55

APPENDIX B

INDEX OF PLANTS CONTAINED IN THIS DETERMINATION

black willow	*Salix nigra*
burhead	*Echinodorus rostratus*
bur oak	*Quercus macrocarpa*
cedar elm	*Ulmus crassifolia*
cocklebur	*Xanthium strumarium*
common balloon-vine	*Cardiospermum halicacabum*
common buttonbush	*Cephalanthus occidentalis*
duckweed	*Lemna minor*
eastern cottonwood	*Populus deltoides*
eastern redbud	*Cercis canadensis*
flat sedge	*Cyperus* sp.
green ash	*Fraxinus pennsylvanica* var. *lanceolata*
Johnson grass	*Sorghum halepense*
osage orange	*Maclura pomifera*
rushes	*Juncus* sp.
sedge	*Carex* sp.
sugarberry	*Celtis laevigata*
swamp privet	*Forestiera acuminata*
water primrose	*Ludwigia peploides*
white ash	*Fraxinus americana*

APPENDIX C

A total of 494 acres was surveyed and 4.4 acres of that was mapped as wetlands.

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